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MANUAL OF RECOMMENDED PRACTICE

FOR

RAILWAY ENGINEERING AND MAINTENANCE OF WAY

CONTAINING THE

DEFINITIONS, SPECIFICATIONS AND PRINCIPLES OF PRACTICE ADOPTED AND RECOMMENDED BY THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION

PUBLICATION APPROVED BY THE BOARD OF DIRECTION.

EDITION OF 1905

PUBLISHED UNDER DIRECTION OF THE COMMITTEE ON PUBLICATIONS

BY THE

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION,

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TERRITORIAL GROUPS OF THE UNITED STATES

Adopted by the

INTERSTATE COMMERCE COMMISSION

For the Compilation of Railway Statistics.

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TERRITORIAL GROUPS OF THE UNITED STATES
ADOPTED BY THE
INTERSTATE COMMERCE COMMISSION
DIVISION OF STATISTICS
FOR THE
COMPILATION OF RAILWAY STATISTICS
I
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Scales
100 0 100 200 300 400 500 600 Miles
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JULIUS BIEN & CO. N.Y.

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PREFACE.

At the Fifth Annual Convention of the American Railway Engineering and Maintenance of Way Association, held at Chicago in March, 1904, it was decided to publish a Manual of the Recommended Definitions, Specifications and Principles of Practice for Railway Engineering and Maintenance of Way Work adopted by the Association at its conventions after due consideration of reports on the various subjects submitted by standing or special committees of the Association.

Owing to the importance and weight that should be justly attributed to the deliberate and carefully expressed opinion of an Association comprising prominent railway officials and specialists in the various classes of work and duties connected with the location, construction, maintenance and operation of railroads, and the influence that this publication will undoubtedly have on railway engineering and maintenance of way work in this country, the Board of Direction has exercised particular care to include in the Manual only such matter as has been carefully and sufficiently considered by the Association prior to its adoption by vote at the annual conventions so as to warrant its publication in this Manual as the practice recommended by the Association. The Manual will be supplemented or issued annually after each annual convention and kept up-to-date by such additions and revision of previously published matter as may be decided on by the Association at each convention, working under special rules governing the publication of the Manual.

The action of the Association in adopting and publishing definitions, specifications and principles of practice is in the nature of recommendations only and not binding on its members or railway companies. It is distinctly within the sphere of the Association's work, as expressed in Article I. of its Constitution, viz.:

"The object of this Association shall be the advancement of knowledge pertaining to the scientific and economical location, construction, operation and maintenance of railroads.

"The means to be employed for this purpose shall be as follows:

"Meetings for the reading and discussion of papers and for social intercourse.

"The investigation of matters pertaining to the objects of this Association through Standing and Special Committees.

"The publication of papers, reports and discussions.

"The maintenance of a library."

As illustrative of the aims and methods of the Association, the following extracts from the remarks of Mr. J. F. Wallace, formerly Chief Engineer of the Isthmian Canal Commission and General Manager of the Illinois Central Railroad, in his inaugural address as the President of the Association at its First Annual Convention in Chicago, March, 1900, will prove pertinent:

"It is unnecessary for me to say that this Association fills a long-felt want, and that it has a broad field to develop. If the work is industriously and systematically carried forward, it will gradually assist us all in attaining the end sought for.

"It has been the custom of engineering and maintenance of way associations heretofore to carry on their work without that system and continuity of purpose which is the only true means of successfully accomplishing the desired results. The work of our Association has been laid out on unique lines. It is the intention to cover the entire field of engineering and maintenance of way research, divide up the subjects in systematic order, and continue and increase our standing committees and the subjects under consideration from time to time in order to do so.

"The first work of each committee should be the collection of facts, which should be properly compiled, condensed and abstracted for the information of the Association at large. As the facts are obtained under the different heads or sub-heads, reports can, of course, be made from time to time by the different committees on these subjects which have been considered.

"The committee should not overlook the necessity and importance of working as a unit and fully comparing and discussing results in committee meetings. When they come before this Association as a body they should come as a unit and act together, and it is expected that they will be prepared to answer all questions that may be asked by members of the Association in regular meetings, and explain or defend the positions taken by the committee.

"We should not forget that we are the servants of the investors in railway securities, and that it is our duty to endeavor to secure the largest possible return on the capital invested. It is the function of the railway to furnish transportation to the public with the maximum amount of speed and safety to person and property, the greatest

convenience to its patrons, and at minimum cost. We should have it in mind that the highest economy in the location, construction, maintenance and operation can only be obtained when the interest on cost of construction, plus the expense of maintenance and operation, are kept down to the minimum.

"The ultimate result of all railroad expenditures is, and should be, net profit to the investor.

"While the question of what is economical management respecting maintenance of way and structures is one which the management of each property must solve for itself, we can certainly assist each other by a full and frank comparison of views and a discussion of the various elements that constitute an economical handling of our maintenance of way work. *The establishment of certain recognized principles as the result of our investigations and discussions will materially assist our managements in adopting a policy that will lead to the truest and highest economy.*"

LIST OF COMMITTEES.

No. I—ROADWAY.

No. II—BALLASTING.

No. III—TIES.

No. IV—RAIL.

No. V—TRACK.

No. VI—BUILDINGS.

No. VII—WOODEN BRIDGES AND TRESTLES.

No. VIII—MASONRY.

No. IX—SIGNS, FENCES, CROSSINGS AND CATTLE-GUARDS.

No. X—SIGNALING AND INTERLOCKING.

No. XI—RECORDS, REPORTS AND ACCOUNTS.

No. XII—UNIFORM RULES, ORGANIZATION, TITLES, CODE, ETC.

No. XIII—WATER SERVICE.

No. XIV—YARDS AND TERMINALS.

No. XV—IRON AND STEEL STRUCTURES.

No. XVI—ECONOMICS OF RAILWAY LOCATION.

SPECIAL COMMITTEE ON CLASSIFICATION OF TRACK.

COMMITTEE NO. 1.

ROADWAY.

*WIDTH OF ROADBED AT SUBGRADE.

RECOMMENDED PRINCIPLES OF PRACTICE.

This Association approves of the opinions of this Committee that on first-class roads of standard gage, with constant and heavy traffic, a minimum permanent width of twenty feet at subgrade is good practice.

That in the theory upon which the width of embankment at subgrade is based it is considered that the track in excavations is placed upon what is virtually a low embankment, and in order to preserve uniformity of conditions immediately under the track throughout the line the width of subgrade in excavations should be made the same as on embankments, outside of which sufficient room must be allowed for side ditches.

†SLOPES OF ROADBED CROSS-SECTION.

RECOMMENDED PRINCIPLES OF PRACTICE.

Local conditions and the character of material should invariably be taken into account in determining the permanent slopes of the roadbed cross-section.

‡SPECIFICATIONS FOR THE CONSTRUCTION OF ROADWAY.

RECOMMENDED PRINCIPLES OF PRACTICE.

(1) Similarity in form of specifications.

(2) Measurements of clearing and grubbing shall be made in units of one hundred (100) ft. square.

(3) A threefold classification of materials: Solid Rock, Loose Rock and Common Excavation, and in special cases such additional classification of material as may seem necessary, such additional classes to be distinctly defined and specified in the contract.

(4) That profiles be made complete in regard to distribution of material, in order to obviate the necessity for overhaul measurements.

*Adopted, Vol. 3, 1902, pp. 34, 37, 43; Vol. 6, 1905, pp. 122, 123.

†Adopted, Vol. 3, 1902, pp. 34, 45; Vol. 6, 1905, pp. 122, 123.

‡Adopted, Vol. 4, 1903, pp. 32, 35, 39, 44, 66, 74; Vol. 5, 1904, pp. 688, 719; Vol. 6, 1905, p. 123.

*DESIGN AND CONSTRUCTION OF ROADWAY.

RECOMMENDED PRINCIPLES OF PRACTICE.

(1) There should be recognized three widths of roadbed for standard gage railways, and these should be selected to suit the probable density of traffic to be handled in the future. These widths should be 14, 16 and 20 ft.

(2) A width of 13 ft. between center lines of main tracks is recommended.

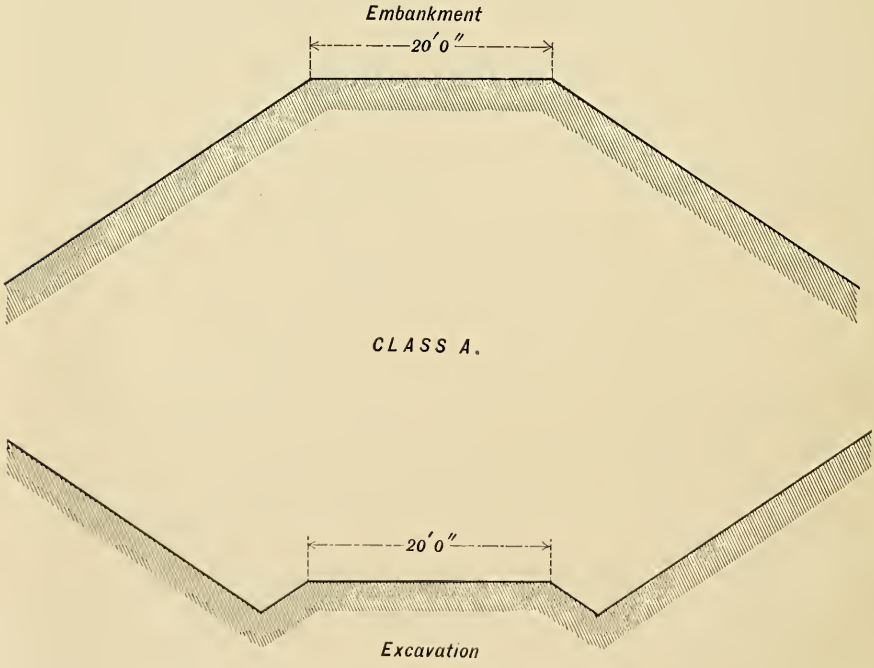
(3) Rock excavations should be taken out not less than 6 in. below subgrade.

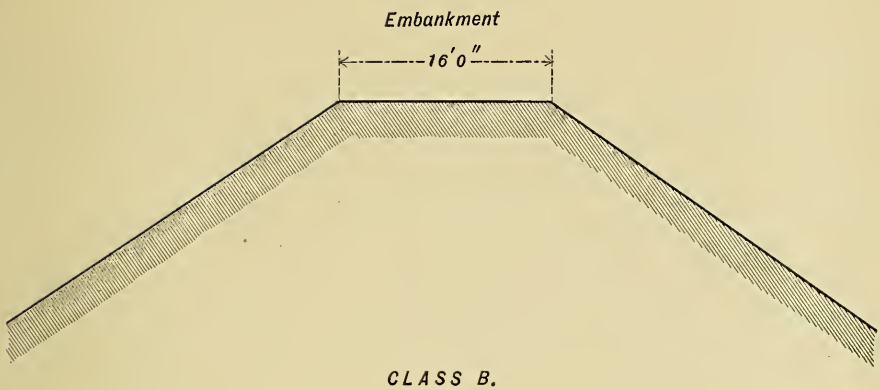
(4) No wasting should be allowed closer than 10 ft. from slope stakes.

(5) That information on profiles as to distribution of material be so arranged that price for grading for each of the classes may cover the haul, irrespective of distance.

*Adopted, Vol. 6, 1905, pp. 136-138, 142, 144, 145, 164-173.

STANDARD ROADBED PLANS.





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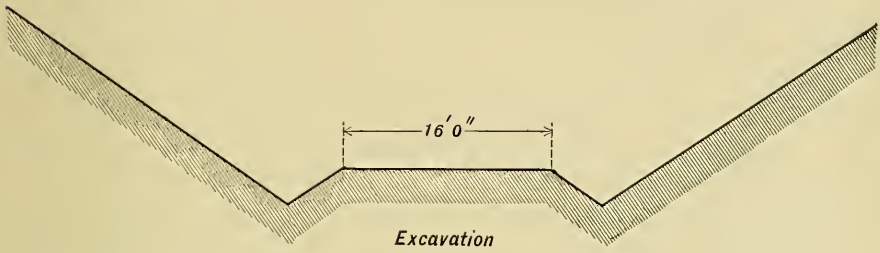

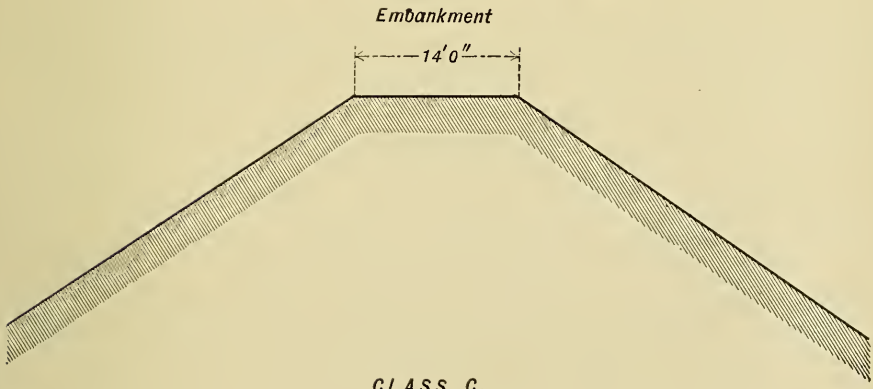

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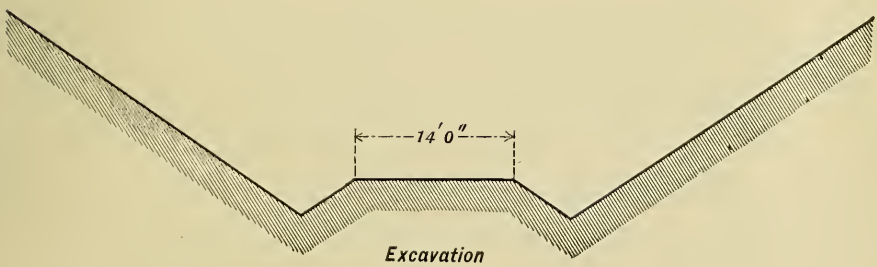

*SPECIFICATIONS FOR THE FORMATION OF THE ROADWAY.

RECOMMENDED STANDARD SPECIFICATIONS.

IN GENERAL.

Alinement.

1. The center of the roadbed shall conform in alinement to the center stakes.

Subgrade.

2. The grade-line on the profile denotes subgrade, and this term indicates the top of embankments or the bottom of excavations ready to receive the ballast.

Cross-section.

3. The roadbed shall be formed to the section, slopes and dimensions shown upon the standard drawings, or to such modifications thereof as are required to meet special conditions, as may be from time to time directed.

Width of Roadbed.

4. When finished and properly settled the roadbed shall conform to the finishing stakes and shall be of the following dimensions at subgrade, for single track, viz.:

On embankments ..... (....) ft. wide, and in excavations ..... (....) ft., exclusive of the width necessary for ditches. For each additional track an additional width of ..... (....) ft. shall be made.

Slopes.

5. The slopes of embankments and excavations shall be of the following inclinations, as expressed in the ratio of the horizontal distance to the vertical rise:

Embankments, Earth—One and one-half to one;
Rock—From one to one, to one and one-half to one;

Excavations, Earth—One and one-half to one;
Loose Rock—One-half to one;
Solid Rock—One-quarter to one.

These ratios may be varied according to circumstances, and the slopes shall be made as directed in each particular case.

CLEARING.

Extent of Clearing.

6. The right-of-way and station grounds, except any portions thereof that may be reserved, shall be cleared of all trees, brush and perishable materials of whatever nature.

*Adopted, Vol. 4, 1903, pp. 20-29, 33-35, 78-109; Vol. 5, 1904, pp. 675-684, 688, 719; Vol. 6, 1905, pp. 125-136, 143-164.

Disposal of Brush, Etc.

7. All these materials, except such as may be hereafter mentioned, shall be burned or otherwise removed from the ground, as may be directed, and without injury to adjoining property.

Stumps.

8. Where clearing is to be done, stumps shall be cut off even with the ground, except between the slope stakes of embankments, where stumps may be cut so that the depth of filling over them will not be less than two and one-half (2½) ft.

Clearing in Advance.

9. The work of clearing shall be kept at least one thousand (1,000) ft. in advance of grading.

Cutting and Piling Wood.

10. All trees which may be reserved shall be stripped of their tops and branches, made into ties, or cut to such lengths as may be directed, and neatly piled at such places on the right-of-way as may be designated, for which service payment will be made by the tie, or by the cord of one hundred and twenty-eight (128) cubic ft.

Fences, Annual Growths, Isolated Trees, Buildings, Etc.

11. Fences, grain, grass or other annual growths and other movable property on the right-of-way shall be carefully removed or piled up, as may be directed, without extra charge, it being understood that the price for clearing covers these items. In localities where isolated trees and buildings exist, payment will be made for their removal at a price to be agreed upon.

Measurement.

12. Measurement of clearing and payment for the same will be by units of one hundred (100) ft. square, or fraction thereof, actually cleared.

GRUBBING.

Extent.

13. Stumps must be grubbed entirely from all places where excavations occur, including ground from which material is to be borrowed as well as from ditches, new channels for waterways and other places where required.

Grubbing will also be required between the slope stakes of all embankments of less than two and one-half (2½) ft. in height.

Grubbing in Advance.

14. The work of grubbing shall be kept at least three hundred (300) ft. in advance of grading.

Measurement.

15. Measurement of grubbing will be estimated upon all excavation actually done, and the space to be covered by all embankments of less than two and one-half (2½) ft. in height. Payment for the same will be by units of one hundred (100) ft. square, or fraction thereof, actually grubbed.

GRADING.

Work Included.

16. The term "Grading" in these Specifications includes all excavations and embankments for the formation of the roadbed, ditching, diversions of roads and streams, foundation pits, and all similar works connected with or appertaining to the construction of the railway, its sidetracks and station grounds.

Classification.

17. All material excavated shall be classified as "Solid Rock," "Loose Rock," "Common Excavation," or such additional classifications of material as may be established before the award of the contract.

Solid Rock.

18. Solid Rock shall comprise rock in solid beds or masses in its original position which may be best removed by blasting, and boulders or detached rock measuring one cubic yard or over.

Loose Rock.

19. Loose Rock shall comprise all detached masses of rock or stone of more than one cubic foot and less than one cubic yard, and all other rock which can be properly removed by pick and bar and without blasting; although steam shovel or blasting may be resorted to on favorable occasions in order to facilitate the work.

Common Excavation.

20. Common Excavation shall comprise all other materials of whatever nature that do not come under the classification of solid rock or loose rock or such other classifications as may be established before the award of the contract.

Finishing Slopes.

21. Slopes of all excavations shall be cut true and straight, and all loose stones in the slopes must be removed.

Excavation Below Subgrade.

22. Rock excavations must in all cases be taken out ..... (....) in. below subgrade and refilled to subgrade with approved material.

Excess Excavation and Slips.

23. Excavation in excess of the authorized cross-section, as well as slides extending beyond the slope lines, shall not be paid for unless such are due to causes which are not under the control of the contractor or his agents. In all cases the surplus material shall be removed by the contractor without delay and the slopes reformed. The classification of the material shall be in accordance with its condition at the time of removal, regardless of prior conditions.

Disposal of Excess Excavation.

24. Where the quantity of excavation exceeds that required to make the embankments to standard cross-section the surplus shall be used to widen the embankments uniformly, along one or both sides, as may be directed, and no material shall be deposited in waste banks unless such waste be indicated either on the profiles or by written order.

Waste Banks.

25. Where wasting is ordered the material shall, if possible, be deposited below grade line, and under no circumstances shall the waste bank have its nearest edge within ..... (....) ft. of the slope stakes of the cutting.

Borrow Pits, Etc.

26. Where the quantity of excavation from the cuttings of standard cross-section is insufficient to form the embankments the deficiency shall be made up by widening the cuttings on one or both sides of the center line, as may be directed, and no material shall be taken from borrow pits unless such borrow be indicated either on the profiles or by written order.

Approximate Quantities Shown.

27. The classification and quantities shown on the profile exhibited for distribution of material are approximate only, and will in no way govern the final estimate. The company reserves the right to increase or diminish the quantities given without affecting the contract unit prices for the various parts of the work.

Reserving Gravel, Etc.

28. Where gravel, stone or any other material suitable for special use of the company is met with in the excavations the same shall, when required, be reserved and deposited in convenient places on the right-of-way, as directed, and other suitable material in the vicinity substituted, as required to complete the embankments.

Berme in Rock Cuttings.

29. A berme of ..... (....) ft. shall be left between the top of slope of rock cuttings and toe of slope of the overlying earth.

Intercepting Ditches.

30. Intercepting ditches when ordered shall be made at the top of the slopes of all cuttings where the ground falls toward the top of the slopes, and they must diverge sufficiently to prevent erosion of the adjoining embankment. The cross-section and location of such ditches will be designated and, if required, they shall be made in advance of opening the cutting.

Ditches in Cuttings.

31. Ditches shall be formed at the bottom of the slopes in cuttings according to the cross-section shown upon the plans, or such modifications thereof as may be directed; they shall be neatly made, clear of obstructions, and at the lower end must diverge sufficiently to prevent erosion of the adjoining embankment.

Subdrains.

32. Subdrains of tile shall be constructed of the size and location as directed. Trenches for these drains must be taken out at least .... (....) in. below frost line; the tiles shall be laid on a bed which shall be true, with half round section, with a filling of at least

..... (....) in. of cinders or other suitable material on either side and above the tile, and then covered with ordinary soil to the top of the trench.

Measurement and payment for such drains will be by the linear foot, according to the diameter of tile, including excavation and refilling; the contractor to furnish all material.

Unsuitable Material.

33. Excavations incident to the construction of the roadbed, ditches, channels and roadways shall be used in forming the embankments; but no frozen or other unsuitable material will be allowed to enter into their composition.

Formation in Layers.

34. When directed, embankments shall be built in horizontal layers of ..... (....) ft. in thickness; these layers to be of the full width of the embankment and built to the true slope, and not widened with loose material from the top. The most suitable material must in all cases be reserved for finishing the surface and no large stones will be allowed within a depth of at least ..... (....) ft. below subgrade.

Shrinkage, Etc.

35. Embankments shall be carried to such height above subgrade and to such increased width as may be deemed a necessary provision for shrinkage, compression and washing. As the embankments become consolidated their sides shall be carefully trimmed to the proper slopes, and they must be maintained to their proper height, dimensions and shape until the work is finally accepted.

Embankments on Slopes.

36. When an embankment is to be placed on sloping ground the surface shall be deeply plowed or stepped; and, whenever directed, boggy or unsuitable material shall be excavated so that the embankment shall be started from a firm foundation.

Embankments Across Swamps.

37. In crossing bogs or swamps of unsound bottom, a special substructure of logs and brushwood may be required, the logs forming this foundation to be not less than six (6) in. in diameter at the small end. If necessary there shall be two or more layers crossing each other at right angles, the logs of each layer being placed close together, with broken joints, and covered closely with brush; the bottom layer shall be placed transversely to the roadway and project at least five (5) ft. beyond the slope stakes of the embankment.

Measurement of this substructure and payment for the same will be by units of one hundred (100) ft. square or fraction thereof of area covered by each layer.

Filling Trestles.

38. In forming embankments from trestles, the material must be thoroughly compacted between the trestle bents and around and under all parts of the structure, and in case of train filling by means of a temporary trestle the material must be uniformly spread in the fill.

Embankments at Trestles.

39. Embankments abutting the ends of trestle bridges shall be brought forward upon the structure a distance of at least ..... (....) ft., with an increased width of ..... (....) ft. in order to form a full roadbed.

Finishing Subgrade.

40. The subgrade must be compact and finished to a true plane, and no depression left that will hold water.

Embankments Over Masonry, Etc.

41. In embankments over or about masonry or other structures the material shall be deposited in thin layers and each layer carefully tamped. Special care must be exercised not to unduly strain these structures, and only the best material will be allowed for the purpose of such filling. The contract price for excavation shall cover the cost of obtaining, distributing and packing the material behind, over and around all such structures.

BORROW PITS.

Land Provided.

42. Land for borrow pits or waste banks will be provided by the railroad company.

Drainage.

43. Borrow pits shall be connected with ditches and drained to the nearest water course, when required. Unless directed, material shall not be borrowed to a depth that will not permit of proper drainage.

Slopes and Bermes.

44. Side slopes of borrow pits on the right-of-way shall be the same as used in the cross-section of the adjoining roadbed. A berme of not less than ..... (....) ft. in width shall be left between slope stakes of the embankment and the edge of the borrow pit, and a berme of not less than ..... (....) ft. between the outside slope of the borrow pit and the right-of-way line. Bermes must consist of the original unbroken ground.

Cross-sectioning of Pits, Etc.

45. Borrow pits shall not be excavated before they have been staked out, and borrowing must be done in regular shape in order to admit of ready and accurate measurement. No borrowing nor wasting of material will be allowed on land set part for station grounds or for other special purposes except by written directions.

PRICE AND MEASUREMENT OF GRADING.

Basis.

46. All grading will be estimated and paid for by the cubic yard at the prices specified for the respective materials. Measurement shall be made in excavation only, except in cases hereinafter mentioned.

Work Included in Price.

47. The contract prices per cubic yard will include the excavation of the material by any method whatever, the loading, transportation and the deposit of the same in the manner described by these Specifications, and in the places designated, the plowing or benching of slopes, as well as all other expense incident to the work of grading.

Haul.

48. Unless otherwise specified, it is distinctly understood that the contract price per cubic yard covers any haul found necessary and that there will be no allowance made for any so-termed overhaul.

Embankment Measurement.

49. If it be impracticable to measure borrowed material in excavation, it may be measured in embankment, using the cross-section notes of the embankment, and making a just and reasonable allowance for change in bulk, so that the quantities shall equal the excavation quantities as nearly as possible.

Borrow Classification.

50. There shall be no classification or allowance made for loose or solid rock in borrow pits unless specific written instructions are given to the contrary, it being the intent and meaning of these specifications that all borrowed material shall be classified and paid for as common excavation.

TUNNEL EXCAVATION.

Line, Grade and Cross-section.

51. Tunnels shall be excavated to the alinement, gradients and sections shown upon the plans, or to such modifications thereof as may be directed.

Bottom of Rock Tunnels.

52. In rock tunnels the material must in all cases be taken out ..... (....) in. below subgrade and refilled to subgrade with approved material.

Blasting.

53. Blasting must be done with all possible care so as not to damage the roof and sides, and all insecure pieces of rock beyond the standard cross-section shall be removed by the contractor.

Excess Excavation.

54. Excavation in excess of the authorized cross-section will not be paid for.

Price to Include.

55. The price paid for tunnel excavation shall embrace the cost of removal of all materials between the outer faces of the portals, and shall

include the loosening, loading, transportation and placing of the material in embankment or waste banks as directed; it shall also include whatever materials and labor are required for temporary props, supports and scaffolding for the safe prosecution of the work, as well as all expense of keeping the tunnel ventilated and free from water, oil or gas.

Niches or Recesses.

56. Niches or recesses for the protection and convenience of the railway employés shall be provided at designated intervals.

Shafts.

57. The location, number and dimensions of all shafts will be determined and the excavation price for them shall cover all materials contained within the specified cross-sections between the surface of the ground and the connection of the shafts with the tunnel; said price will also cover all material and labor for curbing and support of the sides of the shafts as may be required, the cost of keeping the shafts free of water or oil, as well as the cost of all pumping and hoisting machinery.

Wells or Sumps.

58. Wells or pumps within the tunnel necessary for its permanent drainage shall be made as directed and paid for at the same rate per cubic yard as for tunnel excavation.

Right-of-Way for Roads.

59. The contractor will make all arrangements and be at the sole expense for any right-of-way necessary over the top of the tunnel for such roads between the ends of the tunnel as he may need, and all grading necessary for the same will be done at his expense.

Haul.

60. The contract prices per cubic yard for tunnel and shaft excavation, respectively, cover any haul found necessary in placing the material where designated, and there will be no allowance for any so-termed overhaul.

CLAUSES SPECIALLY APPLICABLE TO REVISION OF EXISTING LINE OR WIDENING FOR ADDITIONAL TRACK.

Safety of and Delay to Train Service.

61. The contractor must arrange his work so that there will be no interference or delay in any manner with the train service of the Company, and he will be responsible for any damage to the Company's property caused by his acts or those of his employés. Whenever the work is liable to affect the movement or safety of trains, the method of doing such work must first be submitted for approval, without which it shall not be commenced or prosecuted. If continuous detention occur to the train service, the Company reserves the right to complete the work at the expense of the contractor after giving him written notice.

Precautions for Safety of Trains and Tracks.

62. Heavy blasting will not be allowed close to the main tracks, nor will the contractor be permitted to transport material along or between the Company's tracks, except when properly authorized. Whenever the work as authorized affects the safety of the trains or tracks the Company shall take such precautions as it may deem advisable to ensure safety, and the cost of so doing shall be charged to the contractor and deducted from his estimate.

When and How Company's Tracks May Be Moved.

63. The contractor shall not move or in any way interfere with the Company's tracks under any circumstances. Whenever it becomes necessary that the main line or side tracks be moved, it shall be done by the Company, and the actual cost thereof charged to the contractor and deducted from his estimate.

Location of Additional Track.

64. The location of the additional track will be on the..... side of existing line, but whenever it is expedient to change any portion to the opposite side, the altered alinement will be shown upon the maps or diagrams furnished by the Company, and the contractor shall conform to the same without extra charge.

Plowing Slopes.

65. Whenever the existing embankment of ..... (....) ft. in height or over is raised or widened, the slope of the existing embankment shall be deeply plowed in order to bind the new material thoroughly to it.

Crossings.

66. Wherever it is necessary for material of any description to be transported across the existing track or tracks, the location of the crossings must be approved. The material and labor of placing and maintaining the same will be furnished by the Company and the actual cost charged to the contractor and deducted from his estimate.

Watchmen, Operators and Flagmen.

67. Watchmen, both day and night, will be furnished by the Company at the places it may consider necessary for the safety of the Company's trains and works, and the cost shall be charged to the contractor and deducted from his estimate. It is distinctly understood, however, that the providing of such watchmen shall not relieve the contractor from the liability and payment for damages caused by his operations.

Safety Signals.

68. The cost of installment, maintenance and operation of all signals necessary to ensure the safety of trains, consequent upon the contractor's work, shall be borne by the contractor, and all instructions regarding their observance shall be strictly obeyed by him.

GENERAL CONDITIONS.

Temporary Fences.

69. Previous to or during the work of grading, the contractor, if directed, shall erect and maintain temporary fences in order to prevent trespass upon the railway or damage to adjoining property.

Crossings, Damage to Property, Etc.

70. The contractor shall, at his own expense, make and keep in good condition commodious passing places for public and private roads traversed by the line of railway, and shall be held responsible for damages of whatsoever nature to persons or neighboring property caused by workmen in his employ leaving gates or fences open, blasting rocks, building fires or in other ways, and, if necessary, payment of the estimate may be withheld until such damages are satisfactorily settled for, the intention of the contract being that the Company shall not be held responsible for any claims or losses incurred during the construction of the line, due to the operations or negligence of the contractor or his employés.

Changes of Alinement or Gradients, Etc.

71. The alinement, gradients and cross-sections of the roadbed, as well as ditches and other incidental work, may be altered in part or in whole as deemed necessary either before or after the commencement of the work, but any such change or alteration shall not affect the unit prices specified in the contract. Nor shall any such changes or alteration constitute a claim for damages, nor shall any claim be made or allowed on account of such change or alteration.

Work to Be Paid for as Extra.

72. The contractor shall be paid at contract unit rates only for work actually done, excepting in cases of cuttings, or embankments, where the slopes have actually been completed and accepted.

Snow and Ice.

73. Before beginning grading, as well as during the progress of the work, the contractor must remove all snow and ice from between the slope stakes at his own expense.

Bench Marks and Stakes.

74. The contractor shall carefully preserve all bench marks and stakes, and in case of neglect to do so will be charged with the resulting expense.

Roads.

75. Whenever required the contractor must open up a safe road for passage on horseback and foot along the whole or any portions of the work under contract.

Temporary Roads, Trestles, Etc.

76. No allowance or compensation whatever shall be due or paid to the contractor for any temporary roads, bridges or trestles he may make to facilitate the work.

Final Clearing Up.

77. Before the work is finally accepted the contractor must, at his own expense, clear away from the Company's property, as well as from public and private roads and the channels of streams and ditches, all rubbish and surplus blasted or excavated material.

Extra Work.

78. The cost of any extra work will not be considered or allowed unless such extra work shall have been done by direction in writing, and such written directions must in every case contain the rates and methods of payment for said extra work.

Contractor's Risk.

79. The contractor shall take all risks from casualties of every nature and will not be entitled to any compensation for detentions from such cases. All stock, tools and machinery employed on the work by the contractor are at his risk while on the property of the Railroad Company, and the contractor agrees to make no claim for injury or damage to same which may be caused by the operation of the Railroad.

Company Defined.

80. Whenever the word "Company" is used in these Specifications it designates the ..... Company.

Contractor Defined.

81. The word "Contractor" is used herein to designate the person or persons undertaking the work referred to in these Specifications and drawings.

Work in Charge of.

82. In the foregoing Specifications it is understood and agreed that the Chief Engineer of the ..... Company is in charge of the work, and he may appoint such assistants as he may select. Whenever the Specifications refer to the judgment, direction, decision, approval, etc., of an employé of the ..... Company, they designate and mean that the Chief Engineer or one of his assistants is intended and referred to. The decision of the Chief Engineer shall be final as to the intent and meaning of these Specifications.

Specifications Part of Contract.

83. The Specifications and general conditions referred to are distinctly understood as being embodied with the contract, the whole forming the entire agreement between the Company and the Contractor.

COMMITTEE NO. II.

BALLASTING.

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*BALLASTING.

DEFINITIONS.

BALLAST.—Selected material placed on the roadbed for the purpose of holding the track in line and surface.

BROKEN OR CRUSHED STONE.—Stone broken by artificial means into small fragments of specified sizes.

CHATS.—Tailings from mills in which zinc and lead ores are separated from the rocks in which they occur.

GRAVEL.—Small worn fragments of rock, coarser than sand, occurring in natural deposits.

SAND.—Any hard, granular, comminuted rock material, finer than gravel, and coarser than dust.

CHERT.—An impure flint or hornstone, occurring in beds.

CINDERS.—The residue from the fuel used in locomotives and other furnaces.

SLAG.—The waste product, in a more or less vitrified form, of furnaces for the reduction of ore; usually the product of a blast furnace.

BURNT CLAY.—A clay or gumbo which has been burned into material for ballast.

GUMBO.—A term commonly used for a peculiarly tenacious clay, containing no sand.

†BALLASTING.

GENERAL CONCLUSIONS.

While there is great variation in the qualities of the different natural materials for ballast, the choice of these qualities is not usually

*Adopted, Vol. 5, 1904, pp. 486, 495, 498-501; Vol. 6, 1905, pp. 736, 745.
†Adopted, Vol. 5, 1904, pp. 494, 495, 513, 514; Vol. 6, 1905, pp. 736, 737.

left to the engineer, but has been made already by nature, and all that is left to decide is what is most available or most expedient. This each one must decide for himself in the light of his own circumstances. The question of finance may be a ruling consideration or there may be but one thing to be had, and he must take that or nothing.

In the case of crushed rock, however, the process of manufacture being under control, it is practicable to make the product conform to specifications.

*STONE BALLAST.

RECOMMENDED SPECIFICATIONS.

(1) *Quality.*—(a) Stone shall be durable enough to resist the disintegrating influences of the climate where it is used.

(b) It shall be hard enough to prevent pulverizing under the treatment to which it is subjected.

(c) It shall break in angular pieces when crushed.

(2) *Size.*—(a) The maximum size of ballast shall not exceed pieces which will pass through a screen having 2-in. holes.

(b) The minimum size shall not pass through a screen having ¾-in. holes.

†GRAVEL, CINDERS AND BURNT CLAY BALLAST.

RECOMMENDED PRINCIPLES OF PRACTICE.

‡Gravel.—Gravel should be screened or washed where prevention of dust is an object, but this need not be done where the character of traffic is such that dust is not particularly objectionable. It is recommended that gravel be screened or washed where the proportion of sand or clay exceeds fifty per cent. The minimum size should be such as is retained on screens of 12 meshes per in. By this is meant the size pebble that would be retained in a thorough, careful test.

Cinders.—The use of cinders as ballast is recommended for the following situations: On branch lines with a light traffic; on sidings and yard tracks near point of production; as sub-ballast in wet, spongy places; in cuts and on fills; as sub-ballast on new work where dumps are

* Adopted, Vol. 5, 1904, pp. 487, 495, 501-505; Vol. 6, 1905, pp. 737, 745.
† Adopted, Vol. 6, 1905, pp. 737, 738, 745, 746.
‡ Reported by Committee, but not formally approved by the Association.

settling, and at places where the track heaves from frost. It is recommended that provision be made for wetting down cinders immediately after being drawn.

*Burnt Clay.—The material should be black gumbo or other suitable clay free from sand or silt. The suitability of the material should be determined by thorough testing in a small test kiln before establishing a ballast kiln.

The material should be burned hard and thoroughly.

The fuel used must be fresh and clean enough to burn with a clean fire. It is important that a sufficient supply be kept on hand to prevent interruption of the process of burning.

Burning should be done under the supervision of an experienced and competent burner.

Ballast should be allowed to cool before it is loaded out of the pit.

Absorption of water should not exceed fifteen per cent.

*Reported by Committee, but not formally approved by the Association.

COMMITTEE NO. III.

TIES.

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*TIES.

DEFINITIONS.

†Cross-Tie.—That transverse member of a railway track which supports the rails and by means of which they are retained in position.

Pole Tie.—A tie made from a tree of such size that not more than one tie can be made from a section. Such a tie generally shows sapwood on two sides.

Split Tie.—A tie made by splitting from a tree of such size that two or more ties can be made from a section.

Slab Tie.—A tie made from slabs.

Sawed Tie.—A tie made from a tree of such size that two ties only can be made from a section.

Quartered Tie.—A tie made from a tree of such size that four ties only are made from a section.

†Half-Round Tie.—A slabbed tie which has greater width on lower than on top face.

Slabbed Tie.—A tie sawed on top and bottom only.

Hewed Tie.—A tie hewed on at least two sides.

Sap Tie.—A tie which shows more than a prescribed amount of sapwood in cross-section.

†Heart Tie.—A tie which shows sapwood on the corners only and which sapwood does not measure more than one inch on lines drawn diagonally across the end of tie.

Strict Heart Tie.—A tie having no sapwood.

Wane Tie.—A squared tie showing part of the original surface of the tree on one or more corners.

Doty Tie.—A tie which contains dry rot.

Pecky Tie.—A tie made from a cypress tree which is affected with a fungous disease, known locally as peck.

Tapped Tie.—A tie made from a tree the resin or turpentine of which has been extracted before felling.

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* Adopted, Vol. 5, 1904, pp. 73, 74, 78, 106-120, 131, 132; Vol. 6, 1905, pp. 766, 767.

† Reported by Committee, but not formally approved by the Association.

FORM 1.

STATISTICS OF CROSS-TIE RENEWALS.

FORM 1 A.

COMPARISON BETWEEN DIFFERENT KINDS OF WOOD.

Form 1

STATISTICS OF CROSS-TIE RENEWALS

For Year ending ________ 19__

DIVISION (Report by Division and not by System.)	Miles of Road Operated		Average Gross Tonnage passing over Division in Year	Maximum Weight in Tons		Weight of Main Track Rail in lbs. per yard	*Percentage of Main Track				Kind of Ballast Used. Percentage of Each	Number of Ties in Each Mile of Track		Total Number of Ties Renewed During Year		Per Cent. of Renewals to Number in Tracks			Average Cost Ties Delivered on Ground of Division		*Total Cost of Tie Renewals Per Mile of Track			Average Life of Cross-Ties in			Kind of Timber Used for Ties. If Several Kinds State Percentage of Each
	All Main Tracks	All Tracks Including Sidings		Locomotive and Tender	Fully Loaded Freight Car		Curved	Tie-Plated	Ballasted	Laid with Treated Ties		Main	Side	In Main Tracks	In Side Tracks	Main	Side	Total	Treated Ties	Untreated Ties	All Main Tracks	All Side Tracks	All Tracks	Main Tracks	Side Tracks	All Tracks	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Total for Year																											
Total for Previous Year																											

*To include cost of cross and switch ties, tie-plates, and spike plugs, but not the labor of placing in track.
Omit mileage of new tracks in which tie renewals have not been commenced, and omit number of ties used for new tracks.
Tons of 2,000 lbs. to be used.
Data for columns 25, 26 and 27 kept on Form 1-B.
Data for column 28 given more in detail on Form 1-A.
Bridge ties are to be considered as track ties and included in report.

Form 1—A

COMPARISON BETWEEN DIFFERENT KINDS OF WOOD

For Year Ending ________ 19__

DIVISION (Report by Division and not by System.)	UNTREATED																		TREATED												GRAND TOTALS			No. of tie-plated ties included in totals
	White Oak, Burr Oak, Chestnut Oak			CHESTNUT			PINE			CEDAR			CYPRESS			TOTALS			CREOSOTED			BURNETTIZED			ZINC TANNIN			TOTAL						
	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	
1	2		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Totals																																		

This blank elaborates the information in column 28 of Form 1, and compares the value of the different woods as ties, irrespective of cost.
Do not include ties in new tracks in which renewals have not yet commenced.
See Form 1-C for detail information concerning "preserved" or "treated" ties.
If the headings given do not cover your ties, change them.

FORM 1-B.

LIFE RECORD OF TIES.

FORM 1-C.

STATISTICS OF TREATED TIES.

Form 1—B

LIFE RECORD OF TIES——————RAIL——————

Data completed to——————19——

Total Number of Cross-Ties of all kinds laid in tracks (inc. new tracks)			Total Number of the Cross-Ties Stamped of the Year in Column 1 Removed From Tracks in the Year in Columns 4 to 23 (both inclusive).																				Per cent. remaining in track on date of this report		Average Life in years deduced from renewals	
			1894		1895		1896		1897		1898		1899		1900		1901		1902		1903		Total Removed					
Year	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1888																												
1889																												
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1907																												
1908																												

This blank cannot be tabulated for several Divisions or Railroads. It must be presented for each separately, but will only be printed when considered by the Committee sufficiently complete. When records have not been kept so that this can be filled out for a single year, the member should return it to the Secretary marked "No Data." In course of time it will be a valuable blank to all, and will be easily kept when once started.

This blank furnishes the data for columns 25, 26 and 27 of Form 1.

Explain in body of blank causes for increased or decreased life of ties as years advance.

State in body of blank kinds of timber used for ties and approximate percentage of each kind.

Form 1—C

STATISTICS OF TREATED TIES

For Year Ending——————19——

DIVISION (Report by Division and not by System.)	LIFE OF TREATED TIES IN YEARS																						Antiseptic Used	Amount Injected per Cubic Foot	Number of Treated Ties in Track this date	Number put in Tracks this Year	Average Cost per Tie				Remarks
	Pine				Hemlock				Beech				Spruce														First Cost Untreated	For Extra Handling and Transportation	For Preservative Treatment	Ready for Track	
	Name of Process																														
	Creosote	Burnett-izing	Zinc Tannin		Creosote	Burnett-izing	Zinc Tannin		Creosote	Burnett-izing	Zinc Tannin		Creosote	Burnett-izing	Zinc Tannin		Creosote	Burnett-izing	Zinc Tannin													
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34

The life record of treated ties should be kept by members separately on a blank like Form 1-B.

SCORE MARKS.—Marks made by the ax as a guide for hewing.

SHAKES.—Separations of the wood fiber, due to the action of the wind.

CHECKS.—Small cracks in the wood due to seasoning.

*FACE.—The upper or lower plane surface of a tie.

†FORMS FOR TIE RECORDS.

RECOMMENDED STANDARD FORMS.

Form 1, "Statistics of Cross-Tie Renewals," is intended for general statistical information concerning the life and cost of cross-ties in use on a division, regardless of the kinds of timber, except in a general way.

Form 1-A, "Comparison Between Different Kinds of Wood," is a more detailed comparison between the different kinds of woods and preservative processes, and will explain, in many cases, why the service of ties on one railroad is longer than on another.

Form 1-B, "Life Record of Ties," gives the life record of ties.

Form 1-C, "Statistics of Treated Ties," is intended to give full details concerning the preservation of cross-ties.

Form 1-D, "Report of Marked Ties Removed from Track," is recommended as the proper blank to be used by the Section Foreman for reporting the information required for Form 1-B. This form can also be used for reporting any cross-tie removals when the ties are marked in such a way as to indicate the year laid.

Form 1-D REPORT OF MARKED TIES REMOVED FROM TRACK

On Section_____ Subdivision_____ During Month of_____ 190____

Removed From Main Tracks					Removed From Sidings				
Number Removed	Year Put in as Marked on Tie	Kind of		Cause of Removal	Number Removed	Year Put in as Marked on Tie	Kind of		Cause of Removal
		Timber	Treatment				Timber	Treatment	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

This blank must be sent in monthly by all Foremen on whose sections treated ties have been used, whether any ties have been removed or not. When no ties have been removed, it must be so stated on the blank.

After approval by the Supervisor, it is to be forwarded to the Engineer Maintenance of Way (or other proper officer).

_____

Foreman.

* Reported by Committee, but not formally approved by the Association.

† Adopted, Vol. 3, 1902, pp 102-105, 109-113.

*SPECIFICATIONS FOR TIES.

RECOMMENDED STANDARD SPECIFICATIONS.

Woods to Be Used Untreated.

The following woods may be used for tie timber without any preservative treatment:

White Oak family.
Long-leaf strict heart yellow pine.
Cypress.
Redwood.
White Cedar.
Chestnut.
Catalpa.
Locust, *excepting the honey locust.*
Walnut.
Black Cherry.

Woods to Be Treated.

The following woods shall preferably not be used for tie timber without a preservative treatment approved by the purchaser:

Red Oak family.
Beech.
Elm.
Maple.
Gum.
Loblolly, short-leaf, lodgepole, Western yellow pine, Norway, North Carolina pine and other sap pines.
Red Fir.
Spruce.
Hemlock.
Tamarack.

Material and Manufacture.

All ties must be well and smoothly hewed or sawed out of straight, growing timber of specified dimensions and out of wind, sawed ends, with straight and parallel faces, the minimum width of either face to be not less than that given in the table of dimensions. All ties must have bark entirely removed before being delivered on the company's ground. Ties shall be free from splits, shakes, loose or decayed knots or any other imperfections which may impair their strength or durability.

DIMENSIONS.

Dimensions.

Except in pole ties with rounded sides, *or in half-round ties,* none shall be less than eight (8) in. *width of* face, and in no tie shall the thickness be less than six (6) in. A variation in size will be permitted of one-half (½) in. over in thickness, two (2) in. over in width and one (1) in. over in length.

*Adopted, Vol. 5, 1904, pp. 72, 73, 78, 120-132; Vol. 6, 1905, pp. 763-766.
Amendments made by Committee, but not formally approved by the Association, printed in *italics.*

Allowable Variation.

In pole ties with rounded *sides and half-round ties, the width of* face may be less than that given in the table of dimensions below, but the least area of cross-section shall be not less than the area corresponding to the tabular dimensions, and in no case shall the *width of* face be less than six (6) in.

TABLE OF DIMENSIONS.

Class.	Thickness by *Width of* Face.	Length.		
	Inches.	Feet.	Feet.	Feet.
A	7 x 10	8	8½	9
B	7 x 9	8	8½	9
C	7 x 8	8	8½	9
D	6 x 9	8	8½	9
E	6 x 8	8	8½	9
F	6 x 7	8	8½	9
G	6 x 6	8	8½	9

Piling Ties.

Ties which are to be delivered along the right-of-way of the railroad must be piled at station yards or at points between stations designated in the contract, not less than ten (10) ft. from the nearest rail; each pile to be of either 25 or 50 ties, built with two ties on the ground and above in alternate courses of 7 and 2, except the top, which shall be placed to

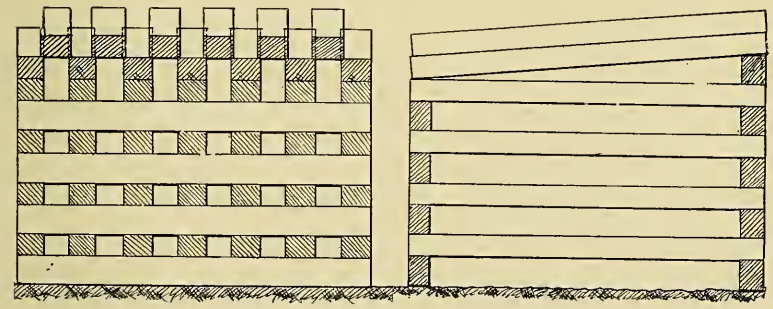


FIG. 1.—PILING DIAGRAM FOR FIFTY TIES.

form a watershed, as shown in diagram. Each pile must be plainly marked with the owner's name. Three feet of space must be left between piles to allow easy inspection. *Sawed ties must be piled separately from hewed ties.*

Removal of Rejected Ties.

All rejected ties must be removed from the company's right-of-way within ten days after notice is given.

Time of Cutting.

Ties shall be cut, as far as possible, in the winter period; that is, from October to March.

COMMITTEE NO. IV.

RAIL.

*MINIMUM STANDARD LENGTH OF RAIL.

RECOMMENDED PRACTICE.

The minimum standard length of rail shall be 33 ft.

†TEMPERATURE EXPANSION FOR LAYING RAILS.

RECOMMENDED PRACTICE.

The table shows the proper allowance to make for expansion for 33-ft. rails.

The temperature shall be taken on the rail, and the openings between the rails shall be as follows:

TEMPERATURE (Fahrenheit)	AMOUNT OF OPENING
—20° to 0°	$\frac{5}{16}$ in.
0° to 25°	$\frac{1}{4}$ in.
25° to 50°	$\frac{3}{16}$ in.
50° to 75°	$\frac{1}{8}$ in.
75° to 100°	$\frac{1}{16}$ in.

Over 100 degrees, to be laid close without bumping.

‡SPECIFICATIONS FOR BESSEMER STEEL RAILS.

RECOMMENDED STANDARD SPECIFICATIONS.

Process of Manufacture.

1. (a) The entire process of manufacture and testing shall be in accordance with the best current practice, and special care shall be taken to conform to the following instructions:

(b) Ingots shall be kept in a vertical position in the pit heating

* Adopted, Vol. 2, 1901, pp. 190, 204-212.

† Adopted, Vol. 2, 1901, pp. 190, 212.

‡ Adopted, Vol. 3, 1902, pp. 204-206, 208-220; Vol. 5, 1904, pp. 465-468, 469-480; Vol. 6, 1905, p. 190.

furnaces until ready to be rolled, or until the metal in the interior has time to solidify.

(c) No bled ingots shall be used.

(d) Sufficient material shall be discarded from the top of ingot to insure sound rails.

2. Rails of the various weights per yard specified below shall conform to the following limits in chemical composition: Chemical Composition.

	50 to 59 Pounds. Per cent.	60 to 69 Pounds. Per cent.	70 to 79 Pounds. Per cent.	80 to 89 Pounds. Per cent.	90 to 100 Pounds. Per cent.
Carbon	0.35-0.45	0.38-0.48	0.40-0.50	0.43-0.53	0.45-0.55
Phosphorus, shall not exceed	0.10	0.10	0.10	0.10	0.10
Silicon, shall not exceed	0.20	0.20	0.20	0.20	0.20
Manganese	0.70-1.00	0.70-1.00	0.75-1.05	0.80-1.10	0.80-1.10

3. One drop test shall be made on a piece of rail not less than four (4) ft. and not more than six (6) ft. long, selected from each blow of steel. The test piece shall be taken from the top of the ingot. The rail shall be placed head upwards on the supports, and the various sections shall be subjected to the following impact tests under a free falling weight: Drop Test.

	Weight of Rail. Pounds Per Yard.	Height of Drop. Feet.
	45 to and including 55	15
More than	55 " 65	16
More than	65 " 75	18
More than	75 " 85	20
More than	85 " 100	22

If any rail break when subject to the drop test, two additional tests will be made of other rails from the same blow of steel, and if either of these latter tests fail, all the rails of the blow which they represent will be rejected, but if both of these additional test pieces meet the requirements, all the rails of the blow which they represent will be accepted.

4. The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saws of 6 in. for 85-lb. and 6⅛ in. for 100-lb. rails, and no artificial means of cooling the rails shall be used between the finishing pass and the hot saws. The above shrinkage allowance may be varied, if necessary, so as to give a finishing temperature of not exceeding 1,600 degrees Fahrenheit at finishing rolls for mills rolling from reheated blooms, and not exceeding 1,750 degrees Fahrenheit at finishing rolls for mills rolling direct from the bloom to finished rail. Shrinkage Allowance (for rails 33 ft. long).

Drop Testing Machine.

5. The drop testing machine shall have a tup of two thousand (2,000) lbs. weight, the striking face of which shall have a radius of not more than five (5) in. and the test rail shall be placed head upwards on solid supports three (3) ft. apart. The anvil block shall weigh at least twenty thousand (20,000) lbs., and the supports shall be part of, or firmly secured to, the anvil. The report of the drop test shall state the atmospheric temperature at the time the test was made.

Chemical Analyses.

6. The manufacturer shall furnish the inspector, daily, with carbon determinations for each blow, and a complete chemical analysis every twenty-four hours, representing the average of the other elements contained in the steel, for each day and night turn. These analyses shall be made on drillings taken from small test ingot.

Section.

7. Unless otherwise specified, the section of rail shall be the American Standard, recommended by the American Society of Civil Engineers, and shall conform, as accurately as possible, to the templet furnished by the railroad company, consistent with paragraph No. 8, relative to specified weight. A variation in height of one sixty-fourth ($\frac{1}{64}$) in. less, or one thirty-second ($\frac{1}{32}$) in. greater than the specified height, and one-sixteenth ($\frac{1}{16}$) in. in width will be permitted. The section of rail shall conform perfectly to the fishing dimension.

Weight.

8. The weight of the rails will be maintained as nearly as possible, after complying with paragraph No. 7, to that specified in contract. A variation of one-half (½) of one per cent. for an entire order will be allowed. Rails shall be accepted and paid for according to actual weights.

Length.

9. The standard length of rails shall be thirty-three (33) ft. Ten per cent. of the entire order will be accepted in shorter lengths, varying by even feet to twenty-seven (27) ft., and all No. 1 rails less than 33 ft. shall be painted green on the end. A variation of one-fourth (¼) in. in length from that specified will be allowed.

Drilling.

10. Circular holes for splice bars shall be drilled in accordance with the specifications of the purchaser. The holes shall accurately conform to the drawing and dimensions furnished in every respect, and must be free from burrs.

Finish.

11. Rails shall be straight when finished, the straightening being done while cold, smooth on head, sawed square at ends, variation to be not over one thirty-second ($\frac{1}{32}$) in., and prior to shipment shall have the burr occasioned by the saw cutting removed and the ends made clean. No. 1 rails shall be free from injurious defects and flaws of all kinds.

Branding.

12. The name of the maker, the weight of rail and the month and year of manufacture shall be rolled in raised letters on the side of the web, and the number of blow shall be plainly stamped on each rail where it will not subsequently be covered by the splice bars.

Inspection.

13. The inspector representing the purchaser shall have free entry to the works of the manufacturer at all times when the contract is being filled, and shall have all reasonable facilities afforded him by the manufacturer to satisfy him that the finished material is furnished in accordance with the terms of these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment.

No. 2 Rails.

14. No. 2 rails will be accepted up to five (5) per cent. of the whole order. Rails that possess any injurious defects, or which for any other cause are not suitable for first quality, or No. 1 rails, shall be considered as No. 2 rails; provided, however, that rails which contain any physical defects which impair their strength shall be rejected. The ends of all No. 2 rails shall be painted white in order to distinguish them. Rails rejected under the drop test will not be accepted as No. 2 rails.

COMMITTEE NO. V.

TRACK.

*TRACK.

DEFINITIONS.

TRACK.—Ties, rails and fastenings with all parts in their proper relative places.

ALINEMENT.—The horizontal location of a railroad with reference to curves and tangents.

LINE.—The condition of the track in regard to uniformity in direction over short distances on tangents, or uniformity in variation in direction over short distances on curves.

TANGENT.—Straight track.

CURVE.—A change in direction by means of one or more radii.

CURVE SIMPLE.—A change in direction by means of a single radius.

CURVE, COMPOUND.—A change consisting of two or more simple curves of different radii, all in the same direction, joining one another at points with common tangent.

CURVE, REVERSE.—Two curves in opposite directions in a continuous line joining at a common tangent point.

CURVE, EASEMENT.—A curve of regular varying radii connecting a tangent to a simple curve, or connecting two simple curves.

CURVE, VERTICAL.—A curve used to connect intersecting grade lines.

SURFACE.—The condition of the track as to vertical evenness or smoothness over short distances.

LEVEL.—The condition of the track in which the elevation of the rails transversely is equal.

ELEVATION (as applied to curves).—The amount which the outer rail is raised above the inner rail.

GAGE, STANDARD.—The gage of 4 ft. 8½ in.

GAGE (OF TRACK).—The distance between the heads of the rails measured at right angles thereto at a point ⅝-in. below the top of the rail.

FASTENINGS.—Splices, bolts, and spikes.

* Adopted, Vol. 5. 1904. pp. 527, 535, 541-560; Vol. 6, 1905, pp. 748, 749, 759-761.

AUXILIARY FASTENINGS.—Nutlocks, tie-plates, rail braces, and anti-creeping devices.

*MAINTENANCE OF LINE AND ALINEMENT.

RECOMMENDED PRACTICE.

(a) Adjustment of Tangents:

Tangents shall be adjusted by throwing the tangent between summits; between curves; or by throwing curves to meet tangent; or by partially throwing curves and partially throwing tangents, as may require the least work. Centers should be set with transit to insure accure line.

(b) Adjustment of Curves, with Consideration as to Easement Curves:

Recommendation: Easement curves shall be used as follows:

For speed not exceeding 30 miles per hour, on all curves exceeding 2 degrees.

For speed not exceeding 60 miles per hour, on all curves exceeding 1 degree.

Where higher speed is attained, on all curves exceeding 30 minutes.

Easement curves shall be used between curves of different degrees in the same way that they are used between curves and tangents.

The length of easement curves shall be the same as the distance in which the curve elevation is run out; therefore, as the elevation of curves depends not alone on the degree, but also on the speed of trains, the length of the easement curve should vary in the same manner.

For ordinary practice, a chord length equivalent to 100 ft. for each degree of variation in curvature is recommended.

Where the distance between curves will not allow this, or for other reasons, a chord length of 25 to 30 ft. may be used.

For very high-speed roads, a chord length equivalent to 150 ft. or more per degree of variation is recommended.

Any form of transition curve is satisfactory which gradually changes the degree of curvature, and in which the length of chord per degree of variation can readily be changed to suit each particular case, the essential point being that the length of the easement curve shall be the same as the distance in which the elevation of the outer rail is raised from zero to full elevation.

Any transition curve of the type of the Searles, Crandall, Holbrook,

*Adopted, Vol. 3, 1902, pp. 55, 56, 67-78; Vol. 5, 1904, pp. 527, 528, 535, 561, 562; Vol. 6, 1905, pp. 753, 754, 759-761.

Talbot or cubic parabola, which shall be susceptible of being run in by deflection or offset, is recommended.

(c) Method of Securing and Maintaining Perfect Line:

Permanent witnesses shall be placed at points of tangent, points of spiral, points of change of curvature, summits, and at such other points along curves or tangents as will enable the alinement to be identically reproduced with a transit.

*MAINTENANCE OF SURFACE.

RECOMMENDED PRACTICE.

(a) Elevation of Curves, with special consideration as to amount and beginning and end of elevation, and as modified by location of curve and conditions of traffic:

The approximate formula,

$$e = \frac{Gv^2}{32.16\,R}$$

in which
e = Elevation in feet,
G = Gage of track in feet,
v = Velocity in feet per second,
R = Radius of curve in feet,

will give essentially correct theoretical elevation for the outer rail of curves, and is recommended for ordinary practice, but must be modified as noted below to suit special conditions.

For greater convenience the formula above may be further reduced by substituting

$$v = \frac{V5280}{3600},$$

$$G = 4.708,$$

$$R = \frac{5730}{D}\ (\text{approx.}),$$

$$e = 1\text{-}12\ E,$$

in which
V = Velocity in miles per hour,
D = Degree of curve,
and
E = Elevation of outer rail in inches;
whence
$E = .00066\ DV^2$.

This formula will give results which are expressed in the accompanying table:

*Adopted, Vol. 3, 1902, pp. 56-59, 78-87; Vol. 5, 1904, pp. 528-533, 535, 562, 563; Vol. 6, 1905, pp. 754-757, 759-761.

ELEVATION OF OUTER RAIL IN INCHES.

Degree of Curve.	Velocity in Miles per Hour.													Degree of Curve.
	10	15	20	25	30	35	40	45	50	55	60	65	70	
1	0	1/8	1/4	3/8	5/8	3/4	1 1/8	1 3/8	1 5/8	2	2 3/8	2 3/4	3 1/4	1
2	1/8	3/8	1/2	7/8	1 1/8	1 5/8	2 1/8	2 5/8	3 1/4	4	4 3/4	5 1/2	6 1/2	2
3	1/4	1/2	3/4	1 1/4	1 3/4	2 3/8	3 1/8	4	4 7/8	6	7 1/8	8 3/8	9 3/4	3
4	1/4	5/8	1	1 5/8	2 3/8	3 1/4	4 1/4	5 3/8	6 5/8	8	9 1/2	.....	.....	4
5	3/8	3/4	1 1/4	2	3	4	5 1/4	6 5/8	8 1/4	.....	.....	.....	.....	5
6	3/8	1	1 3/8	2 1/2	3 1/2	4 7/8	6 1/4	8	.....	.....	.....	.....	.....	6
7	1/2	1 1/8	1 7/8	2 7/8	4 1/8	5 5/8	7 3/8	.....	.....	.....	.....	.....	.....	7
8	1/2	1 1/4	2 1/8	3 1/4	4 3/4	6 1/2	8 3/8	.....	.....	.....	.....	.....	.....	8
9	5/8	1 3/8	2 3/8	3 3/4	5 3/8	7 1/4	.....	.....	.....	.....	.....	.....	.....	9
10	3/4	1 1/2	2 5/8	4 1/8	5 7/8	8 1/8	.....	.....	.....	.....	.....	....	.....	10
11	3/4	1 3/4	2 7/8	4 1/2	6 1/8	8 7/8	.....	.....	.....	.....	.....	.....	.....	11
12	7/8	1 7/8	3 1/8	4 7/8	7 1/8	.....	.....	.....	.....	.....	.....	.....	.....	12
13	7/8	2	3 3/8	5 3/8	7 3/4	.....	.....	....	.....	.....	.....	....	.....	13
14	1	2 1/8	3 5/8	5 3/4	8 3/8	.....	.....	.....	.....	.....	.....	.....	.....	14
15	1	2 1/4	3 7/8	6 1/4	8 7/8	.....	.....	.....	.....	.....	.....	.....	.....	15
16	1 1/8	2 1/2	4 1/4	6 5/8	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
17	1 1/4	2 5/8	4 1/2	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
18	1 1/4	2 3/4	4 3/4	7 1/2	.....	.....	.....	.....	.....	.....	..	.....	.....	18
19	1 3/8	2 7/8	5	7 3/4	.....	.....	.....	.....	.....	.....	.....	.....	.....	19
20	1 3/8	3	5 1/4	8 1/8	.....	.....	.....	.....	.....	.....	.....	.....	.....	20

Since the elevation required is a function of, and depends upon, the train speed, this speed is the first element to be determined.

In general, as a matter of safety, the preference should be given to fast passenger traffic.

Ordinarily an elevation of 8 in. should not be exceeded and speed of trains should be regulated to conform to that elevation.

The elevation of curves shall be zero at the point of spiral and shall increase to full elevation at the end of the spiral or beginning of the simple curve.

In ordinary practice, it is recommended that the elevation be run out at the rate of 1 in. in 60 ft., but this will be modified by the same conditions that should vary the length of the easement curve used.

The inner rail shall be maintained at grade.

(b) Vertical Curves:

The use of vertical curves to connect changes in gradient are so obvious as to require no argument.

The length will be determined by the gradients to be connected. On first-class lines a rate of change of 0.1 per station on summits, and 0.05 per station in sags should not be exceeded. On minor lines 0.2 per station on summits and 0.1 per station in sags may be used.

(c) Proper Methods of Tamping.

(1) Earth or Clay Ballast.

Tools: Shovel equipped with iron cuff or handle for tamping; broad pointed tamping bars.

Work: Tamp each tie from 18 in. inside of the rail to end of tie with handle of shovel or tamping bar. If possible, tamp the end of the tie outside of rail first and let train pass over before tamping inside of rail; give special attention to tamping under the rail; tamp center of ties loosely with the blade of the shovel; the dirt or clay between the ties must be placed in layers and firmly packed with feet or otherwise, so that it will quickly shed the water; the earth must not be banked above the bottom of the ends of the ties; the filling between the ties must not touch the rail and should be as high as, or higher than, the top of the ties in the middle of the track.

(2) Cinder Ballast (Railroad Product):

Tools: Shovel, tamping bar or tamping pick.

Work: Same as for gravel.

(3) Burnt Clay Ballast:

Tools: Shovel only in soft material. When burnt very hard, tamping pick or bar should be used.

Work: Tamp 15 in. inside of rail to end of tie, tamping end of tie first, letting train pass before tamping inside of rail; tamp center loosely; tamp well between the ties; dress ballast same as for earth or cinders.

(4) Broken Stone or Furnace Slag:

Tools: Shovel, tamping pick, stone forks.

Work: Tamp 15 in. inside of rail to end of tie; if possible, tamp the end of the tie outside of rail first and allow train to pass over before tamping inside of rail; tamp well under the rail; tamp well under ties from end of same; do not tamp center of tie; fill in between ties to height of top of tie; bank ballast into shoulder about the end of the ties level with top of tie.

(5) Chat, Gravel or Chert Ballast:

Tools: Shovel, tamping pick or tamping bar. For light traffic, shovel tamping is sufficient. For heavy traffic, the tamping pick or tamping bar should be used. The tamping bar is recommended instead of the tamping pick for ordinary practice.

Work: Tamp solid from a point 15 in. inside of rail to the end of the tie; if possible, tamp the end of the tie outside of the rail first and allow train to pass over before tamping inside of rail; care must be taken not to disturb the old bed. Tie must be tamped solidly from the end, using pick or tamping bar. After train has passed, the center of the tie shall be loosely tamped with the blade of the shovel. Dress same as stone ballast.

(6) General:

When not surfacing out of face, as in case of picking up low joints or other low places, the general level of the track shall not be disturbed. Where the rails are out of level, but where the difference in elevation is not excessive and is uniform over long stretches of track, a difference in elevation between the two rails of $\frac{3}{8}$-in. may be allowed to continue until such time as the track would ordinarily be surfaced out of face.

*MAINTENANCE OF GAGE.

RECOMMENDED PRACTICE.

(a) Methods used to prevent spreading of track and canting of rails on curves.

(1) For heavy traffic, use tie-plates on all ties on curves.

(2) For medium traffic, tie-plate all curves over 3 degrees.

(3) For light traffic, double spike the outside of rails.

(4) Tie-plates are recommended in preference to rail braces, except for guard rails and stock rails at switches, where the latter should be used.

(5) Tie-plates should be applied in all cases where greater economy in maintenance is secured by their use, than in depending on the life of the tie limited by rail wear.

†STANDARD DRILLING FOR RAILS.

RECOMMENDED PRACTICE.

JOINT RECOMMENDATION OF TRACK AND RAIL COMMITTEES.

The standard drilling for rails to be as follows:

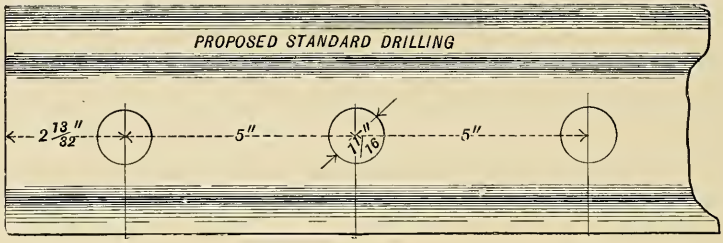
End of rail to center first hole..... 2 $\frac{13}{32}$ in.
Center of first hole to center second hole.....5 in.
Center second hole to center third hole.....5 in.

Diameter of hole in rail to be $\frac{3}{16}$-in. larger than diameter of bolt used.

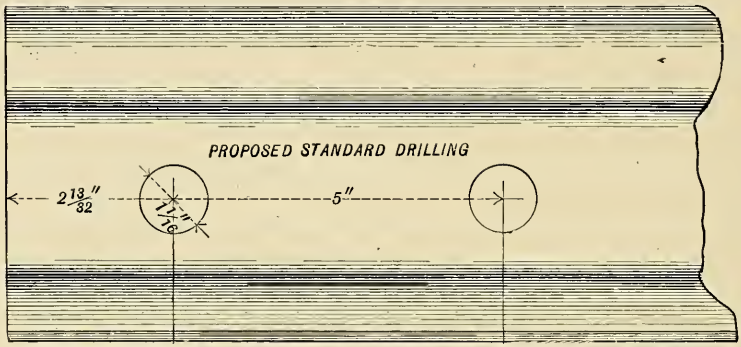
The punching in splices to be alternately oblong and round, to permit staggering bolts in rail, high enough to allow it without flange interference. The round hole (diameter) to be $\frac{1}{16}$-in. larger than the diameter of bolts over thread.

*Adopted, Vol. 5, 1904, pp. 534, 535, 563-569; Vol. 6, 1905, pp. 749, 750, 757, 759-761.

†Adopted. Vol. 5, 1904, pp. 518, 520, 525, 569-571; Vol. 6, 1905, pp. 757, 759-761.



STANDARD DRILLING FOR SIX-HOLE SPLICE.



STANDARD DRILLING FOR FOUR-HOLE SPLICE.

* FROG BLOCKING.

RECOMMENDED PRACTICE.

That the heel of all frogs be made with a steel filler block, to fit the section of rail, securely bolted in with the outer end of filler planed off ⅜-in. below top of rail to act as a riser for the outer edge of worn treads.

That the wings and throat of all frogs be blocked with a metal or wood blocking, shaped to fit rail sections, to give 1½-in. flange clearance, and be securely bolted to frog.

* Adopted, Vol. 5, 1904, pp. 525, 526, 571; Vol. 6, 1905, pp. 757, 758, 759-761.

COMMITTEE NO. VI.

BUILDINGS.

*CONCLUSIONS RELATIVE TO ONE GENERAL WAITING ROOM OR SEPARATE WAITING ROOMS IN A LOCAL PASSENGER STATION (WITHOUT REFERENCE TO SEPARATE WAITING ROOMS FOR COLORED PEOPLE).

RECOMMENDED PRINCIPLES OF PRACTICE.

Your Committee recommends that the Association approve the use of one general waiting room for a local passenger station (without reference to separate waiting rooms for colored people).

Your Committee recommends the use of one general waiting room for a local passenger station, as shown on diagrams †Nos. 1, 2 and 3, for the following reasons:

(1) It allows the general waiting room to be properly proportioned.

(2) It permits proper development of a retiring room for women with private entrance to their toilet.

(3) It readily admits of the other rooms being properly proportioned.

(4) It allows ease of access from Agent's office to the trains, to the Baggage Room and to the Waiting Room.

(5) It allows the ticket office to be used for a registering or an "O. S"ing office.

(6) It admits of the station being contracted in size without detriment of facilities.

(7) Economy in heating.

(8) It admits easily of varied treatment architecturally.

* Adopted, Vol. 6, 1905, pp. 682-684, 690.

† The diagrams accompanying this report were prepared by the Committee to illustrate the reasons for this recommendation, and are not to be considered as typical station plans approved by the Association.

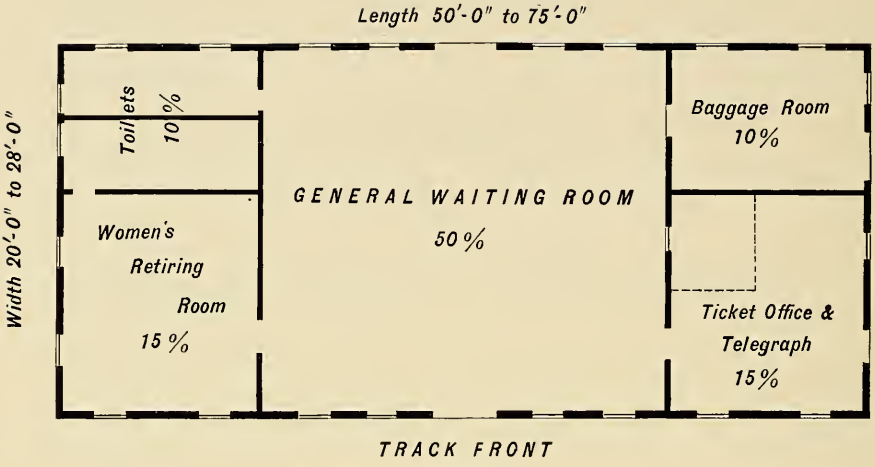

Length 50'-0" to 75'-0"
Width 20'-0" to 28'-0"
Toilets 10%
Women's Retiring Room 15%
GENERAL WAITING ROOM 50%
Baggage Room 10%
Ticket Office & Telegraph 15%
TRACK FRONT

FIG. 1.

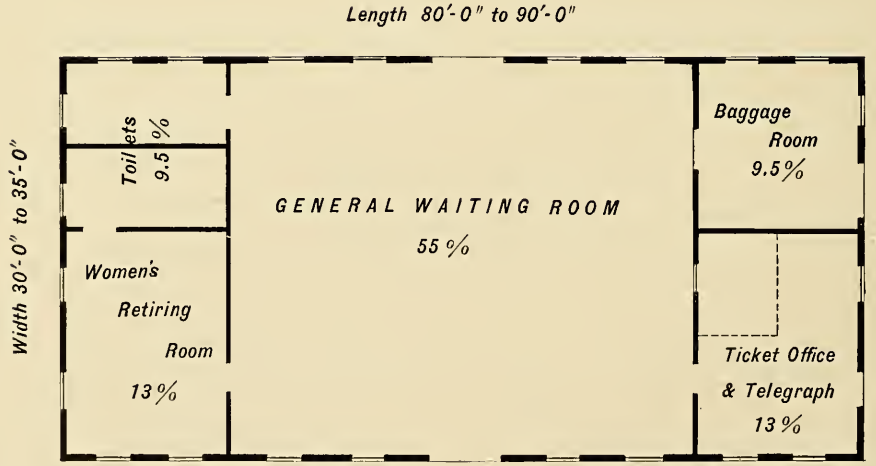

Length 80'-0" to 90'-0"
Width 30'-0" to 35'-0"
Toilets 9.5%
Women's Retiring Room 13%
GENERAL WAITING ROOM 55%
Baggage Room 9.5%
Ticket Office & Telegraph 13%
TRACK FRONT

FIG. 2.

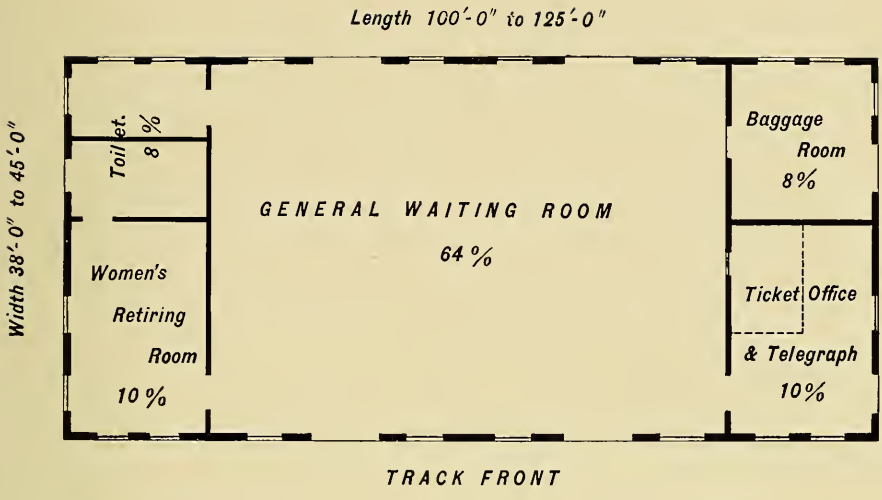


FIG. 3.

*REQUIREMENTS OF A MODERN ROUNDHOUSE.

RECOMMENDED PRACTICE.

Your Committee recommends that a modern roundhouse be designed and equipped as follows:

(1) That in a circular house the locomotives should stand in the house normally with the tender toward the turntable.

(2) That distance from center of turntable to the inner side of roundhouse shall be determined by the number of stalls required in the full circle.

That length of stall along center line of track should be not less than 85 ft. in clear.

(3) That clear opening of entrance doors should be not less than 12 ft. in width and 17 ft. in height.

That the angle between the adjacent tracks should be an even factor of 180°, so that the tracks at the opposite ends of the turntable will "line up" with it.

* Adopted, Vol. 6, 1905, pp. 684-686, 690-696.

(4) The turntable should be not less than 75 ft. in length. The table should be operated by power, preferably electric.

(5) The material used in construction of the house should be non-corrosive, unless proper care be taken to prevent corrosion.

(6) Engine pits should be not less than 60 ft. in length, with convex floor, and with drainage toward the turntable. The walls and floors may be of concrete, and proper provision should be made in construction for the support of the jacking timbers.

(7) Roundhouse doors should be made of non-corrosive material.

(8) Smokejacks should be fixed, having large hoods; constructed preferably of non-corrosive material and supplied with dampers. The cross-section of the stack should be not less than 30 in. in diameter.

(9) The floor should be of permanent construction. It should be crowned between pits, and that part adjacent to pits within jacking limits should be of wood.

(10) Drop pits should be furnished for handling truck wheels, driving wheels and tender wheels. These can be most economically constructed in pairs.

(11) If the building is heated with hot air, it should be by the indirect method, and the supply should be taken from the exterior of the building (no recirculation of air should be allowed). The air should be delivered to the pits under the engine portion of the locomotive. Air ducts should be located under the floor and special precaution should be taken to keep them dry.

(12) As much light should be obtained from the exterior of the building as good construction will allow.

(13) There should be an arc light, and a plug outlet for incandescent lights in each space between stalls.

(14) The contents of boilers should be taken care of and discharged outside of the building in a suitable receptacle and the heat units used as may be deemed best.

(15) Cold water should be supplied at each alternate space between stalls from an outlet not less than 2½ in., located at a point about opposite front end of firebox; the water pressure should be not less than

80 lbs. The hydrants should be located below the floor in properly constructed pits amply drained.

Modern practice requires the use of hot water in the maintenance of boilers.

(16) Compressed air is used for mechanical hoisting and blowing operations. Overhead outlets should be furnished in each space between stalls opposite front end of fire box. The pressure should be from 80 to 100 lbs.

(17) A roundhouse should have facilities for the location of a few necessary machine tools, preferably electrically driven.

(18) Air hoists, or portable gooseneck cranes with differential blocks, on wheels, should be furnished for handling heavy repair parts.

(19) The turntable pit side walls should be of concrete with wooden coping not less than 6 in. thick, and the ties under the circular rail should be supported on concrete walls. Pivot masonry may be of concrete with stone cap.

COMMITTEE NO. VIII.

MASONRY.

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*MASONRY.

GENERAL DEFINITION.

The following definition is adopted by this Association as a comprehensive definition to cover any kind of masonry, and with the further recommendation that in usual practice the word "masonry" be qualified by some proper term to more particularly describe the kind of masonry under consideration:

"Masonry, in its widest sense, includes all constructions of stone or kindred substitute materials, in which the separate pieces are either placed together, with or without cementing material to join them; or, when not separately placed, are encased in a matrix of firmly cementing material."

†MASONRY SPECIFICATIONS.

RECOMMENDED PRINCIPLES OF PRACTICE.

This Association recommends as good practice that railroad companies prepare and use specifications complete in themselves for all kinds of masonry, to be in such form that they may be attached to and form part of specifications and contracts for other railroad construction when desirable.

‡PORTLAND CEMENT CONCRETE.

RECOMMENDED STANDARD SPECIFICATIONS.

Cement.

1. Cement shall be Portland, either American or foreign, which will meet the requirements of the standard specifications.

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* Adopted, Vol. 3, 1902, pp. 310, 347.

† Adopted, Vol. 3, 1902, pp. 310, 348.

‡ Adopted, Vol. 3, 1902, pp. 304-306; Vol. 4, 1903, pp. 386-389, 394, 436-443; Vol. 5, 1904, pp. 610-613, 618, 619, 650-666.

Sand.

2. Sand shall be clean, sharp, coarse, and of grains varying in size. It shall be free from sticks and other foreign matter, but it may contain clay or loam not to exceed five (5) per cent. Crusher dust, screened to reject all particles over one-quarter (¼) in. in diameter, may be used instead of sand if approved by the Engineer.

Stone.

3. Stone shall be sound, hard and durable, crushed to sizes not exceeding two inches in any direction. For reinforced concrete sizes usually are not to exceed three-quarters (¾) in. in any direction, but may be varied to suit character of reinforcing material.

Gravel.

4. Gravel shall be composed of clean pebbles of hard and durable stone of sizes not exceeding two inches in diameter, and shall be free from clay and other impurities except sand. When containing sand in any considerable quantity, the amount of sand per unit of volume of gravel shall be deterimned accurately, to admit of the proper proportion of sand being maintained in the concrete mixture.

Water.

5. Water shall be clean and reasonably clear, free from sulphuric acid or strong alkalies.

Mixing by Hand.

6. (a) Tight platforms shall be provided of sufficient size to accommodate men and materials for the progressive and rapid mixing of at least two batches of concrete at the same time. Batches shall not exceed one cubic yard each, and smaller batches are preferable, based upon a multiple of the number of sacks of cement to the barrel.

(b) Spread the sand evenly upon the platform, then the cement upon the sand and mix thoroughly until of an even color. Add all the water necessary to make a thin mortar and spread again; add the gravel if used, and finally the broken stone, both of which, if dry, should first be thoroughly wet down. Turn the mass with shovels or hoes until thoroughly incorporated, and all the gravel and stone is covered with mortar; this will probably require the mass to be turned four times.

(c) Another approved method, which may be permitted at the option of the Engineer in charge, is to spread the sand, then the cement and mix dry, then the gravel or broken stone; add water and mix thoroughly as above.

Mixing by Machine.

7. A machine mixer shall be used wherever the volume of work will justify the expense of installing the plant. The necessary requirements for the machine will be that a precise and regular proportioning of materials can be controlled and that the product delivered shall be of the required consistency and thoroughly mixed.

Consistency.

8. The concrete shall be of such consistency that when dumped in place it will not require much tamping. It shall be spaded down and tamped sufficiently to level off, and the water should rise freely to the surface.

Forms.

9. (a) Forms shall be well built, substantial and unyielding, properly braced or tied together by means of wire or rods, and shall conform to lines given.

(b) For all important work, the lumber used for face work shall be dressed on one side and both edges to a uniform thickness and width, and shall be sound and free from loose knots, secured to the studding or uprights in horizontal lines.

(c) For backings and other rough work undressed lumber may be used.

(d) Where corners of the masonry and other projections liable to injury occur, suitable moldings shall be placed in the angles of the forms to round or bevel them off.

(e) Lumber once used in forms shall be cleaned before being used again.

(f) The forms must not be removed within thirty-six hours after all the concrete in that section has been placed. In freezing weather they must remain until the concrete has had a sufficient time to become thoroughly set.

(g) In dry but not freezing weather, the forms shall be drenched with water before the concrete is placed against them.

Disposition.

10. (a) Each layer should be left somewhat rough to insure bonding with the next layer above; and, if it be already set, shall be thoroughly cleaned and scrubbed with coarse brushes and water before the next layer is placed upon it.

(b) Concrete shall be deposited in the molds in layers of such thickness and position as shall be specified by the Engineer in charge. Temporary planking shall be placed at ends of partial layers, so that none shall run out to a thin edge. In general, excepting in arch work, all concrete must be deposited in horizontal layers of uniform thickness throughout.

(c) The work shall be carried up in sections of convenient length and each section completed without intermission.

(d) In no case shall work on a section stop within 18 inches of the top.

(e) Concrete shall be placed immediately after mixing, and any having an initial set shall be rejected.

Expansion Joints.

11. (a) In exposed work, expansion joints may be provided at intervals of 30 to 100 ft., as the character of the structure may require.

(b) A temporary vertical form or partition of plank shall be set up and the section behind completed as though it were the end of the structure. The partition shall be removed when the next section is begun, and the new concrete placed against the old without mortar flushing. Locks shall be provided if directed or called for by the plans.

(c) In reinforced concrete the length of these sections may be materially increased at the option of the Engineer.

Facing.

12. (a) The facing will be made by carefully working the coarse material back from the form by means of a shovel, bar or similar tool, so as to bring the excess mortar of the concrete to the face.

(b) About one inch of mortar (not grout) of the same proportions as used in the concrete may be placed next to the forms immediately in advance of the concrete.

(c) Care must be taken to remove from the inside of the forms any dry mortar in order to secure a perfect face.

Proportioning.

13. The proportion of the materials in the concrete shall be as specifically called for by the contract, or as set forth herein, upon the lines left for that purpose; the volume of cement to be based upon the actual cubic contents of one barrel of specified weight.

STRUCTURE.	Parts by Volume			
	Cement	Sand	Gravel	Broken Stone

Finishing.

14. (a) After the forms are removed, which should generally be as soon as possible after the concrete is sufficiently set, any small cavities or openings in the face shall be neatly filled with mortar, if necessary in the opinion of the Engineer. Any ridges due to cracks or points in the lumber may be rubbed down with chisel or wooden float. The entire face may then be washed with a thin grout of the consistency of white-wash, mixed in the same proportion as the mortar of the concrete. The wash should be applied with a brush. The earlier the above operations are performed the better will be the result.

(b) The tops of bridge seats, pedestals, copings, wing walls, etc., when not finished with natural stone coping, shall be finished with a smooth surface composed of one part cement to two parts of granite, or other suitable screenings or sand, applied in a layer one-half (½) to one (1) in. thick. This must be put in place with the last course of concrete.

Water-proofing.

15. Where waterproofing is required, a thin coat of mortar or grout shall be applied for a finishing coat, upon which shall be placed a covering of suitable waterproofing material.

Freezing Weather.

16. Ordinarily concrete to be left above the surface of the ground will not be constructed in freezing weather. Portland cement concrete, however, may be built under these conditions by special instructions. In this case the sand, water and broken stone shall be heated, and in severe cold salt shall be added in the proportion of about two pounds per cubic yard.

Reinforced Concrete.

17. Where concrete is deposited in connection with metal reinforcing, the greatest care must be taken to insure the coating of the metal with cement, and the thorough compacting of the concrete around the metal. Wherever it is practicable the metal should be placed in position first. This can usually be done in the case where the metal occurs in the bottoms of the forms, by supporting the same on transverse wires, or otherwise, when the bottoms of the forms can be flushed with cement mortar, so as to get the mortar under the metal at the same time, and the concrete deposited immediately afterward. The mortar for flushing the bars should be composed of one part cement and two parts sand. The metal used in the concrete shall be free from dirt, oil or grease. All mill scale should be removed by hammering the metal, or preferably by pickling the same in a weak solution of muriatic acid. No salt will be used in reinforced concrete when laid in freezing weather.

*EFFICIENCY OF CONCRETE BACKING FOR STONE FACE WORK.

RECOMMENDED PRINCIPLES OF PRACTICE.

Under certain conditions the use of concrete backing for stone face work is desirable, and is considered good practice when economical.

†IMBEDDING LARGE STONES IN INTERIOR OF HEAVY CONCRETE STRUCTURES.

RECOMMENDED PRINCIPLES OF PRACTICE.

Imbedding large stones in the interior of heavy concrete structures is accepted as good practice when a saving would result, and when the thickness of structure is not less than four (4) ft.

‡THE USE OF CONCRETE UNDER BRIDGE SEATS IN PLACE OF STONE PEDESTALS.

RECOMMENDED PRINCIPLES OF PRACTICE.

Concrete, either plain or reinforced, is recommended as suitable for bridge seats or pedestal caps, and often as more economical than the use of limestone or sandstone.

§ECONOMY AND ADVISABILITY OF SUBSTITUTING REINFORCED CONCRETE FOR THE COMMON FORMS OF CONSTRUCTION FOR SMALL OPENINGS.

RECOMMENDED PRINCIPLES OF PRACTICE.

That good practice permits the substituting of reinforced concrete for the common forms of construction for small openings.

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*Adopted, Vol. 6, 1905, pp. 701, 702, 723, 728.
†Adopted, Vol. 6, 1905, pp. 702, 703, 723, 728.
‡Adopted, Vol. 6, 1905, pp. 703, 724, 728, 729.
§Adopted, Vol. 6, 1905, pp. 703, 704, 724, 728, 729.

*SPECIFICATIONS FOR NATURAL AND PORTLAND CEMENT.

RECOMMENDED STANDARD SPECIFICATIONS.

(Standard Specifications for Cement adopted by the "Joint Committee," embracing representatives from the American Society of Civil Engineers, American Society for Testing Materials, American Institute of Architects, Engineer Department of United States Army, Association of Portland Cement Manufacturers, and American Railway Engineering and Maintenancee of Way Association.)

GENERAL OBSERVATIONS.

(Prepared and adopted by the "Joint Committee.")

1. These remarks have been prepared with a view of pointing out the pertinent features of the various requirements and the precautions to be observed in the interpretation of the results of the tests.

2. The Committee would suggest that the acceptance or rejection under these specifications be based on tests made by an experienced person having the proper means for making the tests.

Specific Gravity.

3. Specific gravity is useful in detecting adulteration or underburning. The results of tests of specific gravity are not necessarily conclusive as an indication of the quality of a cement, but when in combination with the results of other tests may afford valuable indications.

Fineness.

4. The sieves should be kept thoroughly dry.

Time of Setting.

5. Great care should be exercised to maintain the test pieces under as uniform conditions as possible. A sudden change or wide range of temperature in the room in which the tests are made, a very dry or humid atmosphere, and other irregularities vitally affect the rate of setting.

Tensile Strength.

6. Each consumer must fix the minimum requirements for tensile strength to suit his own conditions. They shall, however, be within the limits stated.

Constancy of Volume.

7. The tests for constancy of volume are divided into two classes, the first normal, the second accelerated. The latter should be regarded as a precautionary test only, and not infallible. Som any conditions enter into the making and interpreting of it that it should be used with extreme care.

8. In making the pats the greatest care should be exercised to avoid initial strains due to molding or to too rapid drying out during the first

*Adopted, Vol. 4, 1903, pp. 389-436, 443; Vol. 5, 1904, pp. 605-610; Vol. 6, 1905, pp. 704-718, 723, 724, 726-728.

twenty-four hours. The pats should be preserved under the most uniform conditions possible, and rapid changes of temperature should be avoided.

9. The failure to meet the requirements of accelerated tests need not be sufficient cause for rejection. The cement may, however, be held for twenty-eight days, and a retest made at the end of that period. Failure to meet the requirements at this time should be considered sufficient cause for rejection, although in the present state of our knowledge it cannot be said that such failure necessarily indicates unsoundness, nor can the cement be considered entirely satisfactory simply because it passes the tests.

STANDARD SPECIFICATIONS FOR CEMENT.

GENERAL CONDITIONS.

1. All cement shall be inspected.

2. Cement may be inspected either at the place of manufacture or on the work.

3. In order to allow ample time for inspecting and testing, the cement should be stored in a suitable weather-tight building having the floor properly blocked or raised from the ground.

4. The cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment.

5. Every facility shall be provided by the contractor and a period of at least twelve days allowed for the inspection and necessary tests.

6. Cement shall be delivered in suitable packages with the brand and name of manufacturer plainly marked thereon.

7. A bag of cement shall contain 94 pounds of cement net. Each barrel of Portland cement shall contain four bags, and each barrel of Natural cement shall contain three bags of the above net weight.

8. Cement failing to meet the seven-day requirements may be held awaiting the results of the twenty-eight day tests before rejection.

9. All tests shall be made in accordance with the methods proposed by the Committee on Uniform Tests of Cement of the American Society of Civil Engineers, presented to the Society January 21, 1903, and amended January 20, 1904, with all subsequent amendments thereto. (See addendum to these specifications.)

10. The acceptance or rejection shall be based on the following requirements:

NATURAL CEMENT.

Definition.

11. This term shall be applied to the finely pulverized product resulting from the calcination of an argillaceous limestone at a temperature only sufficient to drive off the carbonic acid gas.

Specific Gravity.

12. The specific gravity of the cement thoroughly dried at 100° C., shall not be less than 2.8.

Fineness.

13. It shall leave by weight a residue of not more than 10 per cent. on the No. 100, and 30 per cent. on the No. 200 sieve.

Time of Setting

14. It shall develop initial set in not less than ten minutes, and hard set in not less than thirty minutes, nor more than three hours.

Tensile Strength.

15. The minimum requirements for tensile strength for briquettes one inch square in cross-section shall be within the following limits, and shall show no retrogression in strength within the periods specified:*

Age.	*Neat Cement.*	Strength.
24 hours	in moist air	50-100 lbs.
7 days	(1 day in moist air, 6 days in water)	100-200 "
28 days	(1 " " " 27 " ")	200-300 "
	One Part Cement, Three Parts Standard Sand.	
7 days	(1 day in moist air, 6 days in water)	25- 75 lbs.
28 days	(1 " " " 27 " ")	75-150 "

Constancy of Volume.

16. Pats of neat cement about three (3) in. in diameter, one-half (½) in. thick at center, tapering to a thin edge, shall be kept in moist air for a period of twenty-four hours.

(a) A pat is then kept in air of normal temperature.

(b) Another is kept in water maintained as near 70° F. as practicable.

17. These pats are observed at intervals for at least 28 days, and, to satisfactorily pass the tests, should remain firm and hard and show no signs of distortion, checking, cracking or disintegrating.

PORTLAND CEMENT.

Definition.

18. This term is applied to the finely pulverized product resulting from the calcination to incipient fusion of an intimate mixture of properly proportioned argillaceous and calcareous materials, and to which no addition greater than 3 per cent. has been made subsequent to calcination.

Specific Gravity.

19. The specific gravity of the cement, thoroughly dried at 100° C., shall be not less than 3.10.

*For example, the minimum requirement for the twenty-four-hour neat cement test should be some value within the limits of 50 and 100 pounds, and so on for each period stated.

20. It shall leave by weight a residue of not more than 8 per cent. on the No. 100, and not more than 25 per cent. on the No. 200 sieve. Fineness.

21. It shall develop initial set in not less than thirty minutes, but must develop hard set in not less than one hour, nor more than ten hours. Time of Setting.

22. The minimum requirements for tensile strength for briquettes one inch square in section shall be within the following limits, and shall show no retrogression in strength within the periods specified:* Tensile Strength.

Age.	*Neat Cement.*	Strength.
24 hours	in moist air	150-200 lbs.
7 days	(1 day in moist air, 6 days in water)	450-550 "
28 days	(1 " " " 27 " ")	550-650 "

One Part Cement, Three Parts Sand.

7 days	(1 day in moist air, 6 days in water)	150-200 lbs.
28 days	(1 " " " 27 " ")	200-300 "

23. Pats of neat cement about three (3) in. in diameter, one-half (½) in. thick at the center, and tapering to a thin edge, shall be kept in moist air for a period of twenty-four hours. Constancy of Volume.

(a) A pat is then kept in air at normal temperature and observed at intervals for at least 28 days.

(b) Another pat is kept in water maintained as near 70° F. as practicable, and observed at intervals for at least 28 days.

(c) A third pat is exposed in any convenient way in an atmosphere of steam, above boiling water, in a loosely closed vessel for five hours.

24. These pats, to satisfactorily pass the requirements, shall remain firm and hard and show no signs of distortion, checking, cracking or disintegrating.

25. The cement shall not contain more than 1.75 per cent. of anhydrous sulphuric acid (SO_3), nor more than 4 per cent. of magnesia (MgO). Magnesia and Sulphuric Acid.

*For example, the minimum requirement for the twenty-four-hour neat cement test should be some value within the limits of 150 and 200 pounds, and so on for each period stated.

ADDENDUM.

ABSTRACT OF METHODS RECOMMENDED BY THE SPECIAL COMMITTEE ON UNIFORM TESTS OF CEMENT OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

SAMPLING.

Selection of Sample.

1. The sample shall be a fair average of the contents of the package; it is recommended that, where conditions permit, one barrel in every ten be sampled.

2. All samples should be passed through a sieve having twenty meshes per linear inch, in order to break up lumps and remove foreign material; this is also a very effective method for mixing them together in order to obtain an average. For determining the characteristics of a shipment of cement, the individual samples may be mixed and the average tested; where time will permit, however, it is recommended that they be tested separately.

Method of Sampling.

3. Cement in barrels should be sampled through a hole made in the center of one of the staves, midway between the heads, or in the head, by means of an auger or a sampling iron similar to that used by sugar inspectors. If in bags, it should be taken from surface to center.

CHEMICAL ANALYSIS.

Method.

4. As a method to be followed for the analysis of cement, that proposed by the Committee on Uniformity in the Analysis of Materials for the Portland Cement Industry, of the New York Section of the Society for Chemical Industry, and published in the *Journal* of the Society for January 15, 1902, is recommended.

SPECIFIC GRAVITY.

Apparatus and Method.

5. The determination of specific gravity is most conveniently made with Le Chatelier's apparatus. This consists of a flask (*D*), Fig. 1, of 120 cu. cm. (7.32 cu. in.) capacity, the neck of which is about 20 cm. (7.87 in.) long; in the middle of this neck is a bulb (*C*), above and below which are two marks (*F*) and (*E*); the volume between these marks is 20 cu. cm. (1.22 cu. in.). The neck has a diameter of about 9 mm. (0.35 in.), and is graduated into tenths of cubic centimeters above the mark (*F*).

6. Benzine (62° Baumé naphtha), or kerosene free from water, should be used in making the determination.

7. The specific gravity can be determined in two ways:

(a) The flask is filled with either of these liquids to the lower mark (*E*), and 64 gr. (2.25 oz.) of powder, previously dried at 100° C. (212° F.) and cooled to the temperature of the liquid, is gradually introduced through the funnel (*B*) [the stem of which extends into the flask to the top of the bulb (*C*)], until the upper mark (*F*) is reached. The difference in weight between the cement remaining and the original quantity (64 gr.) is the weight which has displaced 20 cu. cm.

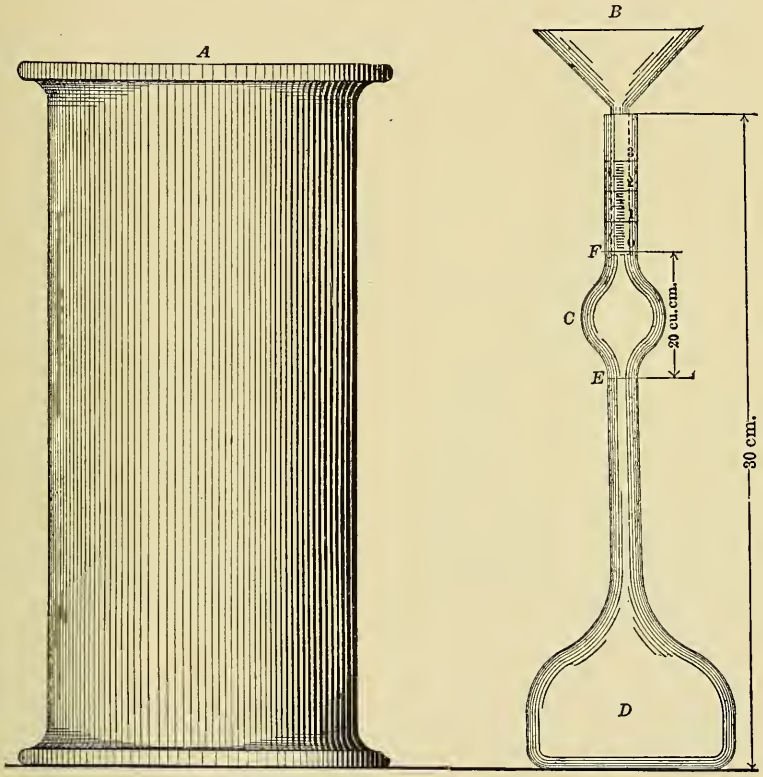

FIG. 1.—LE CHATELIER'S SPECIFIC GRAVITY APPARATUS.

8. (b) The whole quantity of the powder is introduced, and the level of the liquid rises to some division of the graduated neck. This reading plus 20 cu. cm. is the volume displaced by 64 gr. of the powder.

9. The specific gravity is then obtained from the formula:

$$\text{Specific Gravity} = \frac{\text{Weight of Cement.}}{\text{Displaced Volume.}}$$

10. The flask, during the operation, is kept immersed in water in a jar (*A*), in order to avoid variations in the temperature of the liquid. The results should agree within 0.01.

11. A convenient method for cleaning the apparatus is as follows: The flask is inverted over a large vessel, preferably a glass jar, and shaken vertically until the liquid starts to flow freely; it is then held still in a vertical position until empty; the remaining traces of cement can be

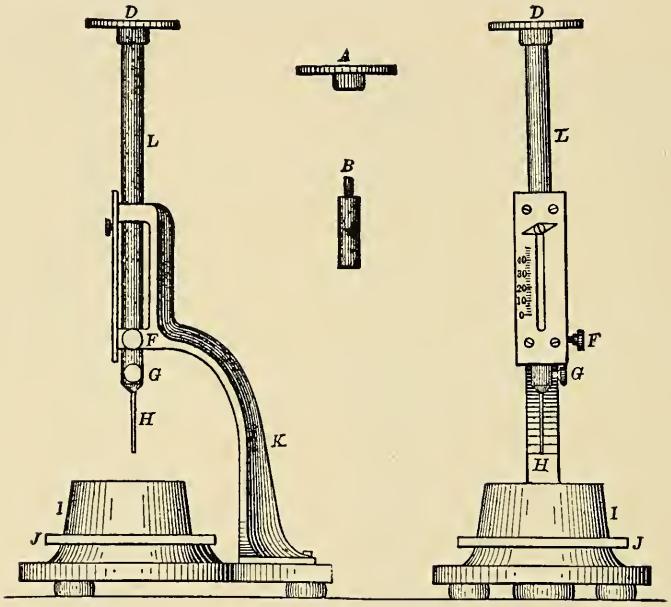

FIG. 2.—VICAT NEEDLE.

removed in a similar manner by pouring into the flask a small quantity of clean liquid and repeating the operation.

FINENESS.

Apparatus. 12. The sieves should be circular, about 20 cm. (7.87 in.) in diameter, 6 cm. (2.36 in.) high, and provided with a pan 5 cm. (1.97 in.) deep, and a cover.

13. The wire cloth should be woven (not twilled) from brass wire having the following diameters:

No. 100, 0.0045 in.; No. 200, 0.0024 in.

14. This cloth should be mounted on the frames without distortion; the mesh should be regular in spacing and be within the following limits:

No. 100, 96 to 100 meshes to the linear inch.
No. 200, 188 to 200 " " " " "

15. Fifty grams (1.76 oz.) or 100 gr. (3.52 oz.) should be used for the test, and dried at a temperature of 100° C. (212° F.) prior to sieving. **Method.**

16. The thoroughly dried and coarsely screened sample is weighed and placed on the No. 200 sieve, which, with pan and cover attached, is held in one hand in a slightly inclined position, and moved forward and backward, at the same time striking the side gently with the palm of the other hand, at the rate of about 200 strokes per minute. The operation is continued until not more than one-tenth of 1 per cent. passes through after one minute of continuous sieving. The residue is weighed, then placed on the No. 100 sieve and the operation repeated. The work may be expedited by placing in the sieve a small quantity of large shot. The results should be reported to the nearest tenth of 1 per cent.

NORMAL CONSISTENCY.

17. This can best be determined by means of *Vicat Needle Apparatus,* which consists of a frame (*K*), Fig. 2, bearing a movable rod (*L*), with the cap (*A*) at one end, and at the other the cylinder (*B*), 1 cm. (0.39 in.) in diameter, the cap, rod and cylinder weighing 300 gr. (10.58 oz.). The rod, which can be held in any desired position by a screw (*F*), carries an indicator, which moves over a scale (graduated to centimeters) attached to the frame (*K*). The paste is held by a conical, hard-rubber ring (*I*), 7 cm. (2.76 in.) in diameter at the base, 4 cm. (1.57 in.) high, resting on a glass plate (*J*), about 10 cm. (3.94 in.) square. **Method.**

18. In making the determination, the same quantity of cement as will be subsequently used for each batch in making the briquettes [but not less than 500 gr. (17.16 oz.)] is kneaded into a paste, as described in paragraph 38, and quickly formed into a ball with the hands, completing the operation by tossing it six times from one hand to the other, maintained 6 in. apart; the ball is then pressed into the rubber ring, through the larger opening, smoothed off, and placed (on its large end) on a glass plate and the smaller end smoothed off with a trowel; the paste, confined in the ring, resting on the plate, is placed under the rod bearing the cylinder, which is brought in contact with the surface and quickly released.

19. The paste is of normal consistency when the cylinder penetrates

to a point in the mass 10 mm. (0.39 in.) below the top of the ring. Great care must be taken to fill the ring exactly to the top.

20. The trial pastes are made with varying percentages of water until the correct consistency is obtained.

Note. The Committee on Standard Specifications inserts the following table for temporary use, to be replaced by one to be devised by the Committee of the American Society of Civil Engineers.

PERCENTAGE OF WATER FOR STANDARD MIXTURES.

Neat	1-1	1-2	1-3	1-4	1-5	Neat	1-1	1-2	1-3	1-4	1-5
18	12.0	10.0	9.0	8.4	8.0	33	17.0	13.3	11.5	10.4	9.6
19	12.3	10.2	9.2	8.5	8.1	34	17.3	13.6	11.7	10.5	9.7
20	12.7	10.4	9.3	8.7	8.2	35	17.7	13.8	11.8	10.7	9.9
21	13.0	10.7	9.5	8.8	8.3	36	18.0	14.0	12.0	10.8	10.0
22	13.3	10.9	9.7	8.9	8.4	37	18 3	14.2	12.2	10.9	10.1
23	13.7	11.1	9.8	9.1	8.5	38	18.7	14.4	12.3	11.1	10.2
24	14.0	11.3	10.0	9.2	8.6	39	19.0	14.7	12.5	11.2	10.3
25	14.3	11.6	10.2	9.3	8.8	40	19.3	14.9	12.7	11.3	10.4
26	14.7	11.8	10.3	9.5	8.9	41	19.7	15.1	12.8	11.5	10.5
27	15.0	12.0	10.5	9.6	9.0	42	20.0	15.3	13.0	11.6	10.6
28	15.3	12.2	10.7	9.7	9.1	43	20.3	15.6	13.2	11.7	10.7
29	15.7	12.5	10.8	9.9	9.2	44	20.7	15.8	13.3	11.9	10.8
30	16.0	12.7	11.0	10 0	9.3	45	21.0	16.0	13.5	12.0	11.0
31	16.3	12.9	11.2	10.1	9.4	46	21.3	16.1	13.7	12.1	11 1
32	16.7	13.1	11 3	10.3	9 5	.....	.....	.....	.....	.....	.....

	1 to 1	1 to 2	1 to 3	1 to 4	1 to 5
Cement.....	500	333	250	200	167
Sand.....	500	667	750	800	833

TIME OF SETTING.

Method.

21. For this purpose the Vicat Needle, which has already been described in paragraph 17, should be used.

22. In making the test, a paste of normal consistency is molded and placed under the rod (*L*), Fig. 2, as described in paragraph 18; this rod, bearing the cap (*D*) at one end and the needle (*H*), 1 mm. (0.039 in.) in diameter, at the other, weighing 300 gr. (10.58 oz.). The needle is then carefully brought in contact with the surface of the paste and quickly released.

23. The setting is said to have commenced when the needle ceases to pass a point 5 mm. (0.20 in.) above the upper surface of the glass plate, and is said to have terminated the moment the needle does not sink visibly into the mass.

24. The test pieces should be stored in moist air during the test;

this is accomplished by placing them on a rack over water contained in a pan and covered with a damp cloth, the cloth to be kept away from them by means of a wire screen; or they may be stored in a moist box or closet.

25. Care should be taken to keep the needle clean, as the collection of cement on the sides of the needle retards the penetration, while cement on the point reduces the area and tends to increase the penetration.

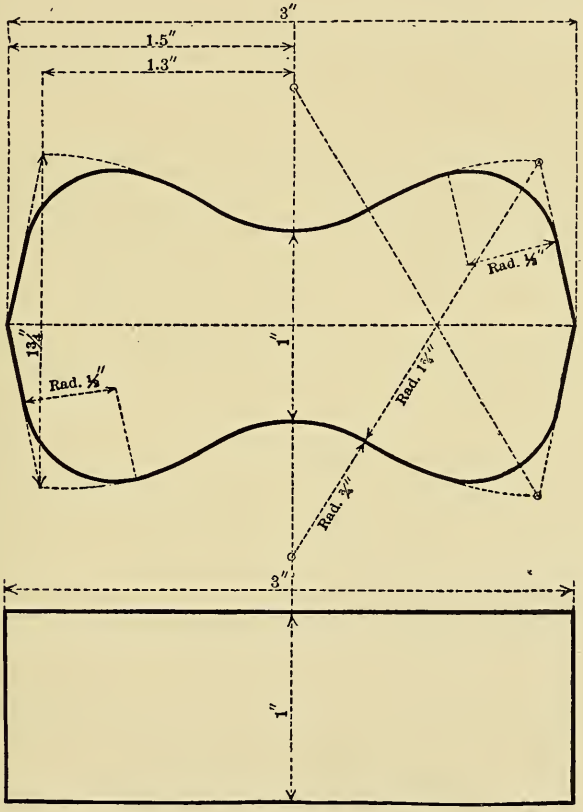

FIG. 3.—DETAILS FOR BRIQUETTE.

26. The determination of the time of setting is only approximate, being materially affected by the temperature of the mixing water, the temperature and humidity of the air during the test, the percentage of water used, and the amount of molding the paste receives.

STANDARD SAND.

27. For the present, the Committee recommends the natural sand from Ottawa, Ill., screened to pass a sieve having 20 meshes per linear inch and retained on a sieve having 30 meshes per linear inch; the wires to have diameters of 0.0165 and 0.0112 in., respectively, *i. e.*, half the width of the opening in each case. Sand having passed the No. 20 sieve shall be considered standard when not more than 1 per cent. passes a No. 30 sieve after one minute continuous sifting of a 500-gr. sample.

28. The Sandusky Portland Cement Company of Sandusky, Ohio, has agreed to undertake the preparation of this sand and to furnish it at a price only sufficient to cover the actual cost of preparation.

FORM OF BRIQUETTE.

29. While the form of the briquette recommended by a former Committee of the Society is not wholly satisfactory, this Committee is not prepared to suggest any change, other than rounding off the corners by curves of ½-in. radius, Fig 3.

MOLDS.

30. The molds should be made of brass, bronze or some equally non-corrodible material, having sufficient metal in the sides to prevent spreading during molding.

31. Gang molds, which permit molding a number of briquettes at one time, are preferred by many to single molds; since the greater quantity of mortar that can be mixed tends to produce a greater uniformity in the results. The type shown in Fig. 4 is recommended.

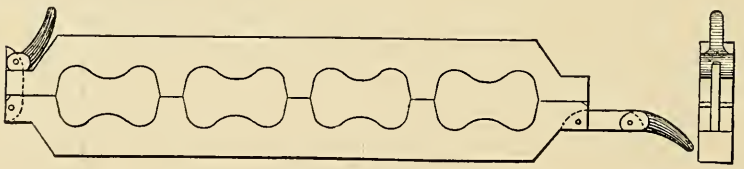

FIG. 4.—DETAILS FOR GANG MOLD.

32. The molds should be wiped with an oily cloth before using.

MIXING.

33. All proportions should be stated by weight; the quantity of water to be used should be stated as a percentage of the dry material.

34. The metric system is recommended because of the convenient relation of the gram and the cubic centimeter.

35. The temperature of the room and the mixing water should be as near 21° C. (70° F.) as it is practicable to maintain it.

36. The sand and cement should be thoroughly mixed dry. The mixing should be done on some non-absorbing surface, preferably plate glass. If the mixing must be done on an absorbing surface it should be thoroughly dampened prior to use.

37. The quantity of material to be mixed at one time depends on the number of test pieces to be made; about 1,000 gr. (35.28 oz.) makes a convenient quantity to mix, especially by hand methods.

38. The material is weighed and placed on the mixing table, and a crater formed in the center, into which the proper percentage of clean water is poured; the material on the outer edge is turned into the crater by the aid of a trowel. As soon as the water has been absorbed, which should not require more than one minute, the operation is completed by vigorously kneading with the hands for an additional 1½ minutes, the process being similar to that used in kneading dough. A sand-glass affords a convenient guide for the time of kneading. During the operation of mixing, the hands should be protected by gloves, preferably of rubber. **Method.**

MOLDING.

39. Having worked the paste or mortar to the proper consistency, it is at once placed in the molds by hand.

40. The molds should be filled at once, the material pressed in firmly with the fingers and smoothed off with a trowel without ramming; the material should be heaped up on the upper surface of the mold, and, in smoothing off, the trowel should be drawn over the mold in such a manner as to exert a moderate pressure on the excess material. The mold should be turned over and the operation repeated. **Method.**

41. A check upon the uniformity of the mixing and molding is afforded by weighing the briquettes just prior to immersion, or upon removal from the moist closet. Briquettes which vary in weight more than 3 per cent. from the average should not be tested.

STORAGE OF THE TEST PIECES.

42. During the first 24 hours after molding, the test pieces should be kept in moist air to prevent them from drying out.

43. A moist closet or chamber is so easily devised that the use of the damp cloth should be abandoned if possible. Covering the test pieces with a damp cloth is objectionable, as commonly used, because the cloth

may dry out unequally, and in conseqence the test pieces are not all maintained under the same condition. Where a moist closet is not available, a cloth may be used and kept uniformly wet by immersing the ends in water. It should be kept from direct contact with the test pieces by means of a wire screen or some similar arrangement.

44. A moist closet consists of a soapstone or slate box, or a metal-lined wooden box—the metal lining being covered with felt and this felt

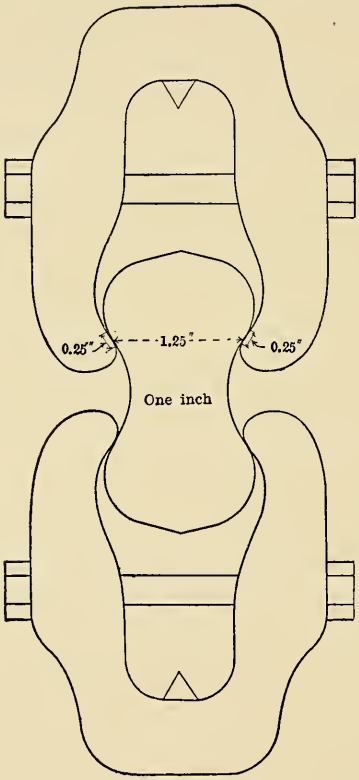

FIG. 5.—FORM OF CLIP.

kept wet. The bottom of the box is so constructed as to hold water, and the sides are provided with cleats for holding glass shelves on which to place the briquettes. Care should be taken to keep the air in the closet uniformly moist.

45. After 24 hours in moist air, the test pieces for longer periods of time should be immersed in water maintained as near 21° C. (70° F.) as practicable; they may be stored in tanks or pans, which should be of non-corrodible material.

TENSILE STRENGTH.

46. The tests may be made on any standard machine. A solid metal clip, as shown in Fig. 5, is recommended. This clip is to be used without cushioning at the points of contact with the test specimen. The bearing at each point of contact should be ¼-in. wide, and the distance between the centers of contact on the same clip should be 1¼ in.

47. Test pieces should be broken as soon as they are removed from the water. Care should be observed in centering the briquettes in the testing machine, as cross-strains, produced by improper centering, tend to lower the breaking strength. The load should not be applied too suddenly, as it may produce vibration, the shock from which often breaks the briquette before the ultimate strength is reached. Care must be taken that the clips and the sides of the briquette be clean and free from grains of sand or dirt which would prevent a good bearing. The load should be applied at the rate of 600 lbs. per minute. The average of the briquettes of each sample tested should be taken as the test, excluding any results which are manifestly faulty.

CONSTANCY OF VOLUME.

48. Tests for constancy of volume are divided into two classes: (1) Normal tests, or those made in either air or water maintained at about 21° C. (70° F.), and (2) accelerated tests, or those made in air, steam or water at a temperature of 45° C. (115° F.) and upward. The test pieces should be allowed to remain 24 hours in moist air before immersion in water or steam, or preservation in air. Methods.

49. For these tests, pats about 7½ cm. (2.95 in.) in diameter, 1¼ cm. (0.49 in.) thick at the center, and tapering to a thin edge, should be made, upon a clean glass plate [about 10 cm. (3.94 in.) square], from cement paste of normal consistency.

50. A pat is immersed in water maintained as near 21° C. (70° F.) as possible for 28 days, and observed at intervals. A similar pat is maintained in air at ordinary temperature and observed at intervals. Normal Test.

51. A pat is exposed in any convenient way in an atmosphere of steam, above boiling water, in a loosely closed vessel. Accelerated Test.

52. To pass these tests satisfactorily, the pats should remain firm and hard, and show no signs of cracking, distortion or disintegration.

53. Should the pat leave the plate, distortion may be detected best with a straight-edge applied to the surface which was in contact with the plate.

COMMITTEE NO. IX.

SIGNS, FENCES, CROSSINGS AND CATTLE-GUARDS.

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*FENCES.

DEFINITIONS.

FENCE.—A line of posts and rails or wires, or of boards and pickets; a wall, hedge, ditch, trench, bank or anything that serves to guard against unrestricted ingress and egress.

FENCE POST.—An upright piece of timber, metal or other material used as a support for the attachment of the longitudinal members of the fence.

END POST.—A post at the end of a line or section of fence.

INTERMEDIATE POST.—Any post used between end posts.

GATE POST.—A post to which a gate is hung or latched.

†ANCHOR POST.—A fence post secured by an anchor.

CLEAT.—A piece of wood or metal fastened transversely to the sides of a post below the ground line to give it greater stability.

BRACE.—A piece of timber or metal, in compression, placed diagonally or horizontally between any post and the next post to it.

STAY.—A form of timber, metal or other material, whether vertical or inclined, serving the purpose of keeping the longitudinal wires the proper distance apart and stiffening the fence.

STAY WIRE.—A stay formed of wire.

FENCE STAPLE.—A metal device, in the shape of the letter "U" with ends sharpened, for fastening the longitudinal members of the fence to the post.

PANEL.—A section of fence between adjoining posts.

BRACE PANEL.—A panel in which a brace, or tie, or both, are introduced.

TOP WIRE.—The highest longitudinal wire of a fence.

INTERMEDIATE WIRE.—Any longitudinal wire located between top and bottom wires.

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*Adopted, Vol. 5, 1904, pp. 381, 382, 390, 446-451; Vol. 6, 1905, pp. 781, 782.

† Reported by Committee, but not formally approved by the Association.

BOTTOM WIRE.—The lowest longitudinal wire of a fence.

TIE WIRE.—A wire in tension between any two posts used to assist the brace.

GATE.—A movable barrier consisting of a frame or structure of wood, metal or other material for closing a passage or opening in a fence.

GATE LATCH.—A device for fastening the free end of a gate to a gate post.

GATE FRAME.—The sustaining parts of a gate, fitted and framed together, to which the other longitudinal and vertical members are attached.

GATE BRACE.—A piece of wood or metal serving the purpose of stiffening the frame of a gate.

GATE HINGE.—A device for attaching a gate to a post and upon which the gate swings.

*FENCE ANCHOR.—A piece or pieces of wood, metal or other material fastened to the end of a post below the surface of the ground for the purpose of preventing the post from being pulled up.

†SURFACE CATTLE-GUARDS.

DEFINITIONS.

CATTLE-GUARD.—A barrier used at the intersection of a wing-fence with a railroad track to prevent the passage of live stock along the track.

APRON.—The flaring panel of fence set parallel with the track between the cattle-guard and the wing-fence.

WING-FENCE.—The line of fence making connection between the apron of the cattle-guard and the right-of-way or line fence.

SECTION.—A group of slats or strips which go to make up a surface cattle-guard.

FILLER.—A piece of timber, metal, or other material used between the slats composing a section of a surface cattle-guard to space and stiffen them.

SLAT.—Strips of wood or metal to be used singly or in groups to make up sections of a surface cattle-guard.

‡FENCES.

RECOMMENDED PRACTICE.

(1) The use of smooth wire in preference to barbed wire for railroad fences.

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* Reported by Committee, but not formally approved by the Association.
† Adopted, Vol. 5, 1904, pp. 386, 390, 458, 459.
‡ Adopted, Vol. 5, 1904, pp. 388, 455-457; Vol. 6, 1905, 781, 782.

(2) The use of heavier smooth wire than has generally been adopted.

(3) The use of a heavy smooth wire, or a plank at top of barbed wire fence.

*CATTLE-GUARDS.

RECOMMENDED PRACTICE.

The use of the surface in preference to the pit cattle-guard.

†GENERAL REQUIREMENTS FOR SURFACE CATTLE-GUARDS.

RECOMMENDED PRINCIPLES OF PRACTICE.

Your Committee recommends the use of a surface cattle-guard, and that it be designed as nearly as possible to meet the following requirements:

(1) It should be so constructed as to overcome the objectionable features of the pit guard, particularly so far as endangering trains is concerned. Projecting surfaces which would be liable to be caught by dragging brake or other rigging should be avoided.

(2) The cattle-guard should be of such construction as not to endanger employes who pass over it in the discharge of their duties.

(3) It should be effective as to all kinds of live stock, and at the same time have no parts which would catch and hold stock that might endeavor to pass.

(4) It should be reasonable in first cost, durable and easily applied and removed, so as to allow repairs of track at minimum expense.

(5) It should not rattle during the passage of trains.

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* Adopted, Vol. 5, 1904, pp. 388, 460, 461.
† Adopted, Vol. 5, 1904, pp. 387, 390, 459, 461, 462.

COMMITTEE NO. X.

SIGNALING AND INTERLOCKING.

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*TRAIN-ORDER SIGNALS.

RECOMMENDED PRACTICE.

The American Railway Association's third and fourth requisites of installation of interlocking plants are: (3) "Signals, if practicable (to be) either over or upon the right of and adjoining the track to which they

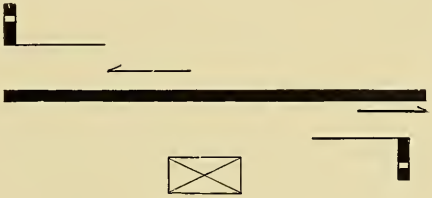


FIG. I.

refer." (4) "Semaphore arms that govern (to be) displayed to the right of the signal mast as seen from an approaching train."

The *first* recommendation, therefore, of your Committee is that these two requisites be adopted with reference to *fixed* train-order signals for all numbers of tracks from one up, as illustrated in Figs. 1 and 2.

The *second* recommendation is that where it may be deemed advisable, for special reasons, to use a bracket mast, no more than two uprights be placed on the bracket. One of these uprights may be a stub to indicate

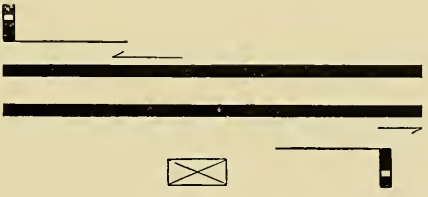


FIG. 2

a track not signaled. In other words, no more than one track should intervene between a bracket signal mast and the track for which its left upright carries the signal arm. This is illustrated in Fig. 3.

*Adopted, Vol. 4, 1903, pp. 295-297, 299, 315-346.

The *third* recommendation of your Committee is the recognition of the use of flags and hand lamps.

It seems to your Committee that it is proper to recognize the current practice of using flags by day and hand lamps by night. It is important, though, that a regular place for displaying these be predetermined, and there seems to be no better way than to place a regular flag socket with hook on the side of the signal station toward the direction of the approaching train, and convenient for the operator to reach from one of the windows.

The *fourth* recommendation is the definition of "Train-Order Signal," as follows: "A fixed signal of two indications, which in the stop

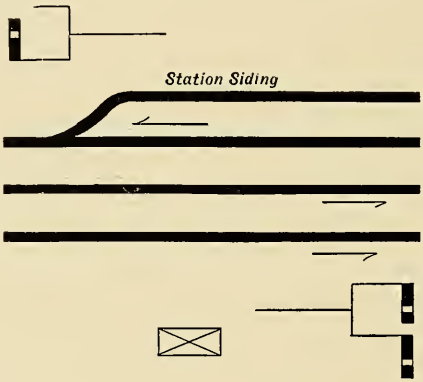


FIG. 3.

position informs the engineman and conductor that they are to receive orders at the telegraph office, and in the clear position announces that there are no orders for them."

The *fifth* recommendation is that this Association recommends as the best practice a fixed train-order signal, with a sweep of arm of 90 degrees from the horizontal.

The *sixth* recommendation is that the plan of a fixed train-order signal with a sweep of arm of 90 degrees, and with a spectacle casting arranged on the continuous-light principle, as shown in Figs. 4, 5, 6 and 7, be adopted as a recommended standard of the American Railway Engineering and Maintenance of Way Association.

This signal is suitable for either a train-order, or interlocking, or automatic block signal. It can be used for either two or three indications, and is suitable for those roads having red for "stop," green for

"caution" and white for "proceed" or "no orders." Furthermore, it is adaptable for roads desiring to be more economical and put two arms on one mast for both directions, because the top of the mast can then be made flat and the lamp placed thereon. The mast, as well as the signal arm and casting, is recommended for standard, but neither the color of arm nor light is under consideration in the present report.

*COMPENSATION OF PIPE LINES.

RECOMMENDED PRACTICE.

(1) Allowance for temperature shall be made in accordance with table (Fig. 8).

(2) The length of compensating arms of Lazy Jack compensators to be 13 or 16 in.

(3) One compensator of the Lazy Jack pattern with 13-in. arms is sufficient for a line 700 ft. long, and with 16-in. arms is sufficient for a line 1,200 ft. long.

†STANDARD ARRANGEMENT OF SIGNALS AT INTERLOCKING PLANTS.

RECOMMENDED PRINCIPLES OF PRACTICE.

(1) That, inasmuch as interlocking signal plants were introduced to make the passage of trains safe at speed over track layouts more or less complicated by crossovers, turnouts, and crossings, the object in arranging interlocking signals is primarily to indicate *routes* for trains, and, secondarily, as a necessary consequence, *speeds* for trains.

(2) That high-speed movements be governed by high signals, and low-speed movements be governed by low signals.

(3) That only two high-speed signals be displayed on one mast, the top arm to govern the unrestricted speed and the lower arm to govern all other high speeds.

(4) That all low-speed movements be governed by one-arm low signals of dwarf construction.

(5) That a distant signal be provided for each high-speed route.

* Adopted, Vol. 4, 1903, pp. 298, 299, 346.
† Adopted, Vol. 6, 1905, pp. 506, 527, 547-552.

STANDARD SEMAPHORE ARM FOR TELEGRAPH BLOCK SIGNAL.

TWO POSITION.

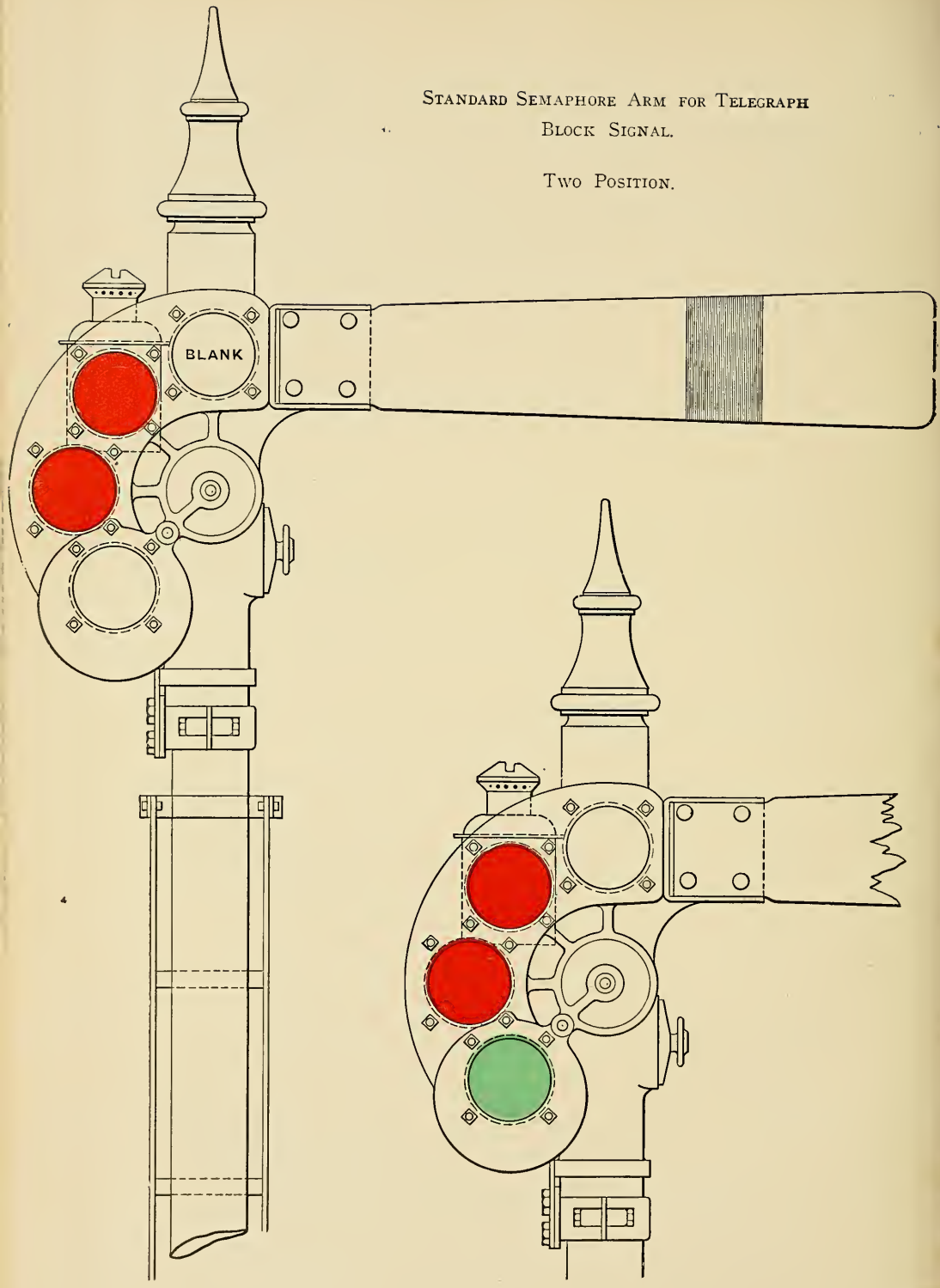
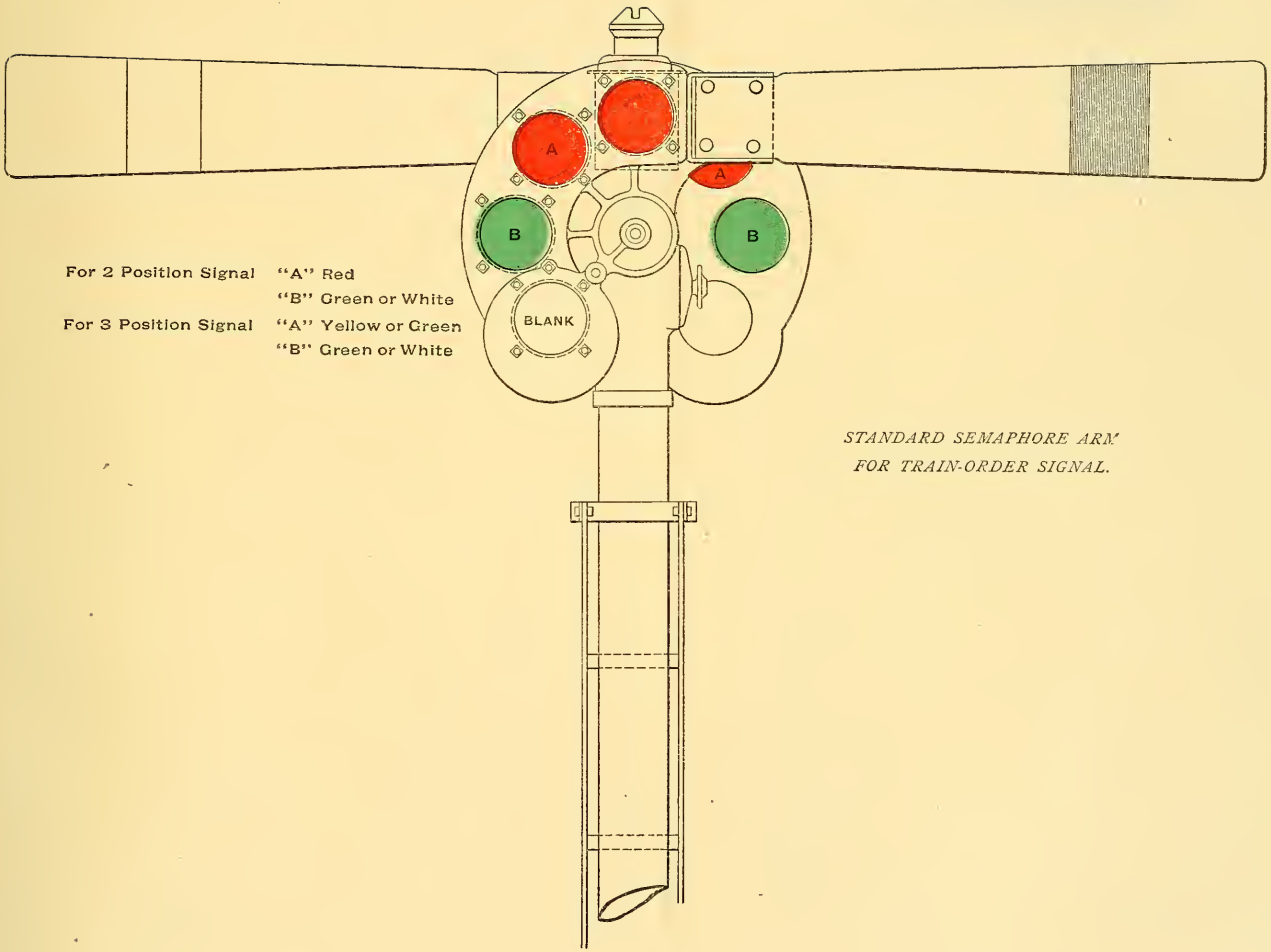


FIG. 5.

FIG. 4.

STANDARD SEMAPHORE ARM FOR
TRAIN-ORDER SIGNAL.



For 2 Position Signal "A" Red
"B" Green or White
For 3 Position Signal "A" Yellow or Green
"B" Green or White

STANDARD SEMAPHORE ARM FOR TRAIN-ORDER SIGNAL.

STANDARD SEMAPHORE ARM FOR TELEGRAPH BLOCK SIGNAL.

THREE POSITION.

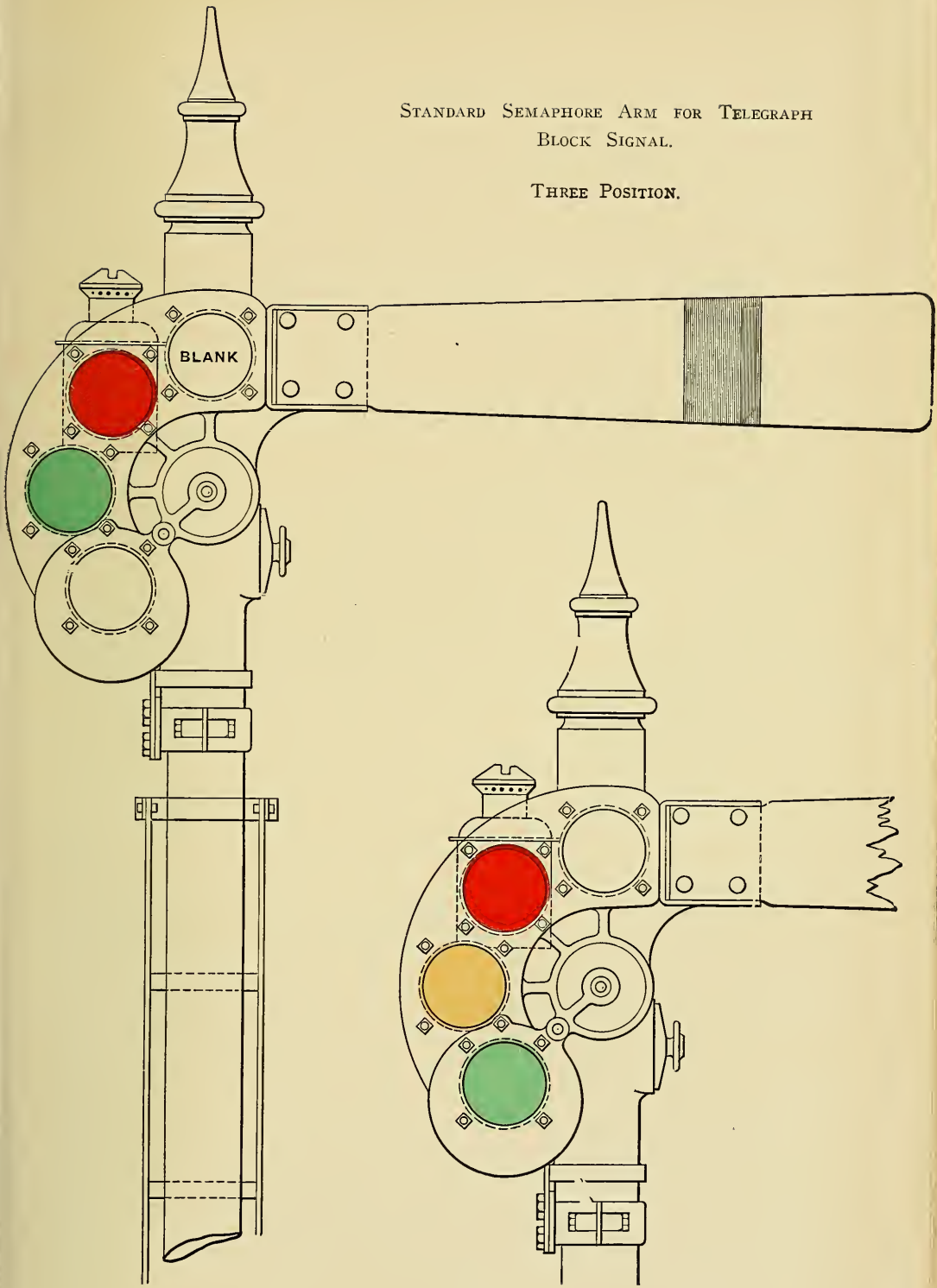


FIG. 6.

DETAIL OF STANDARD SEMAPHORE ARM CASTING.

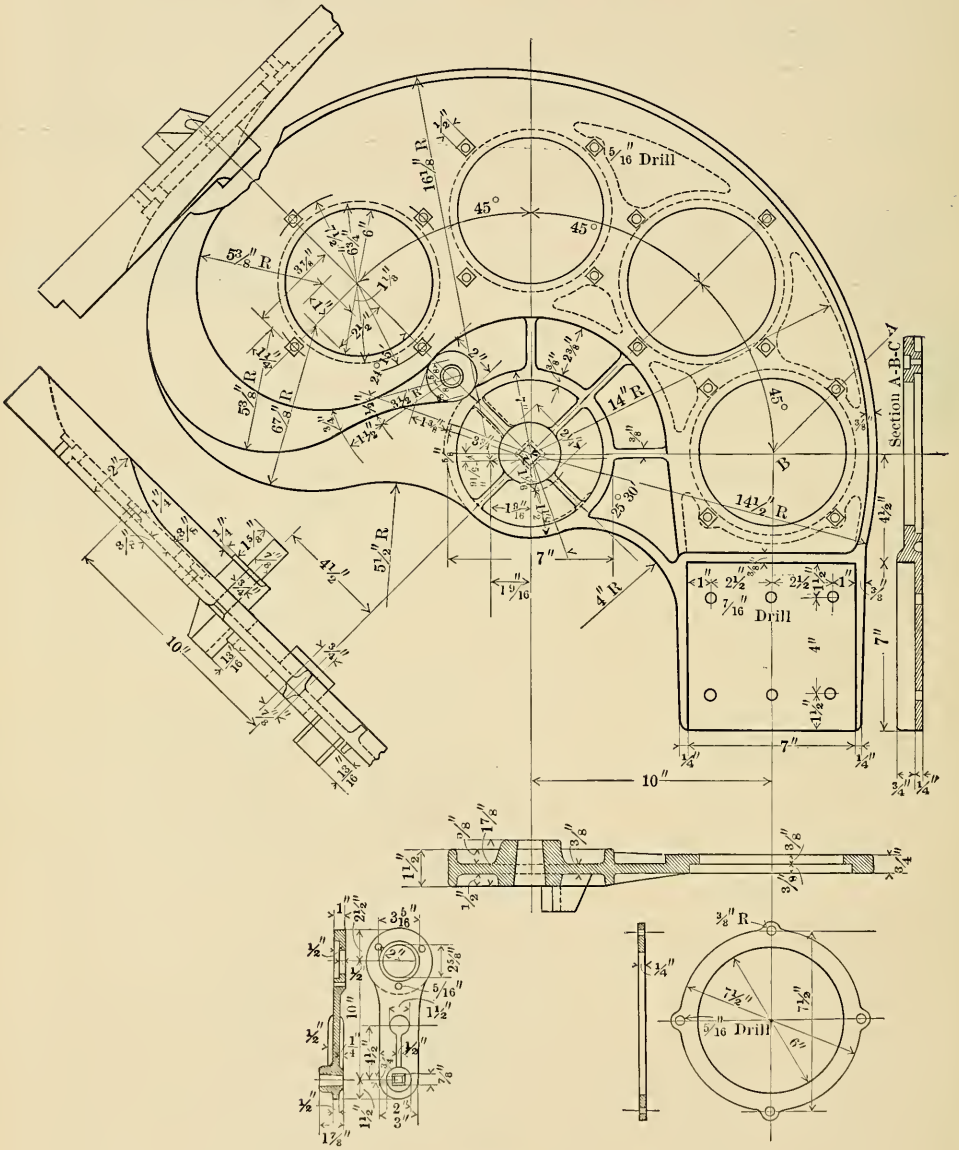
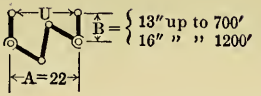


FIG. 7.



Values of U are based on .08 of an inch as coefficient of expansion for an increase of 10° Fahr. for each 100 ft. of line, and the nearest 1-16 inch is given.

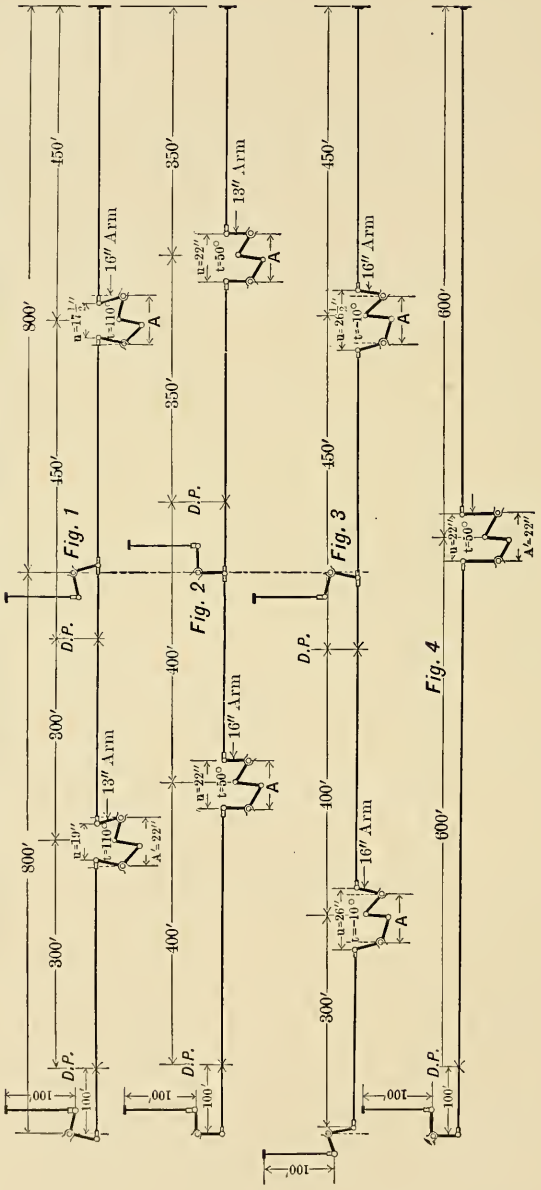
FIG. 8.—VALUES OF SPACING "U" FOR GIVEN TEMPERATURES AND LENGTHS OF LINES TO BE COMPENSATED.

TEMP F°	LENGTH OF LINES COMPENSATED IN FEET											
	100	200	300	400	500	600	700	800	900	1000	1100	1200
110°	21½″	21″	20½″	20″	19½″	19″	18½″	18″	17½″	17″	16½″	16″
90°	21 1/16″	21⅛″	21″	20 1/16″	20⅛″	20″	19 1/16″	19⅛″	19″	18 1/16″	18½″	18¼″
70°	21 3/16″	21 1/16″	21 9/16″	21⅜″	21 3/16″	21″	20 7/8″	20 1/16″	20½″	20⅜″	20¼″	20⅛″
50°				MEAN	TEMPER	ATURE	U=A=22″					
30°	22 3/16″	22 5/16″	22½″	22⅝″	22 13/16″	23″	23 3/16″	23 5/16″	23½″	23⅝″	23¾″	23 15/16″
10°	22 5/16″	22⅝″	23″	23 5/16″	23⅝″	23 15/16″	24¼″	24 9/16″	24⅞″	25 3/16″	25½″	25⅞″
0°	22 7/16″	22 13/16″	23¼″	23⅝″	24 1/16″	24 7/16″	24 13/16″	25¼″	25 1/16″	26⅛″	26½″	26 13/16
−10°	22½″	23″	23½″	24″	24½″	25″	25½″	26″	26½″	27″	27½″	28″

Since the mean temperature varies, it must be taken for the latitude where the work is done.

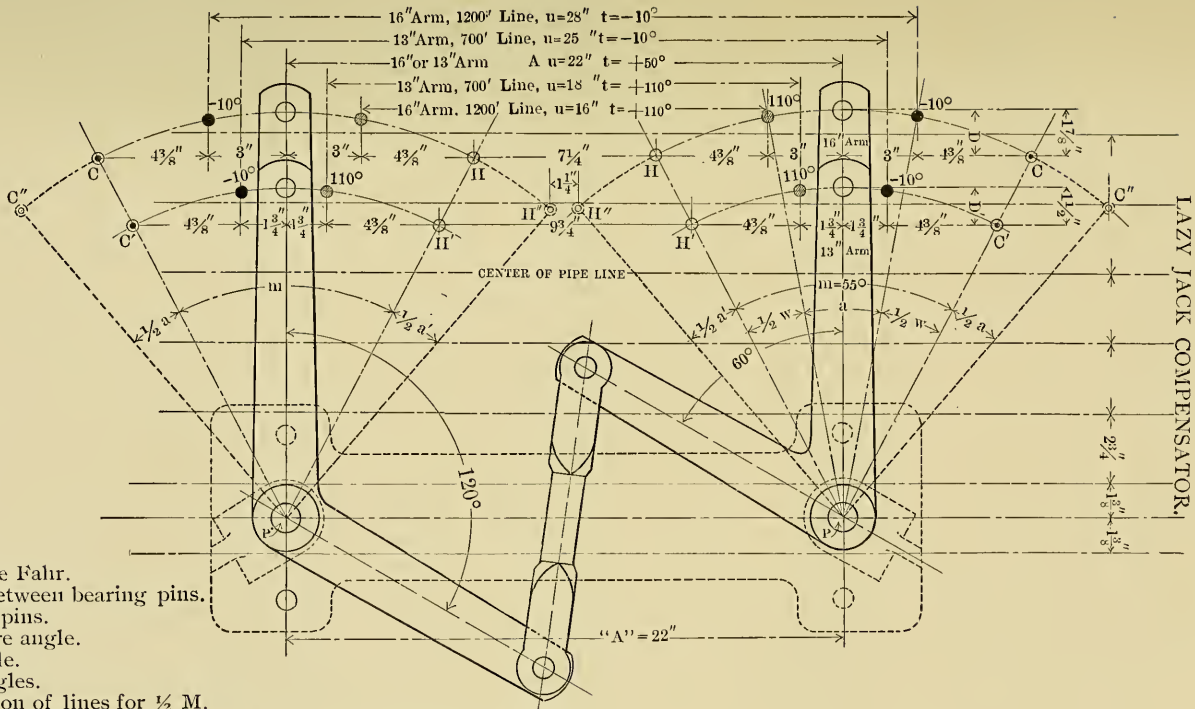
FIG. 9.

LOCATIONS OF COMPENSATORS AND EFFECT OF TEMPERATURE.



LAZY JACK COMPENSATOR.

FIG. 10.



t=Temperature Fahr.
A=Distance between bearing pins.
P P′=Bearing pins.
a=Temperature angle.
u=Stroke angle.
m=A + W angles.
D D′=Deflection of lines for ½ M.
C C′=Extreme open position of arms for max. length of lines at t=10°.
H H′= " closed " " " " " " " " t=110°.
C″ P& { " open " of arm " 1200′ " of line at t=10°, when
C″ P′ { omitting allowance for temperature in setting at t=110°.
P″ P & { Extreme open position of arms for 1200′ length of line at t=110°,
H″ P′ { when omitting allowance for temperature in setting at t=10°.

(6) That "red" be the "color" stop indication, and that the "horizontal" position of the arm be the "position" stop indication for all home signals.

(7) That a mark of distinction be made between automatic block signals, and all other home signals, whether interlocking, train-order, or manually operated block signals.

(8) That home block signals be provided at all interlocking plants used as block stations.

(9) That all mechanically operated high-speed signals be pipe connected. (Low-speed signals may be wire connected.)

(10) That one distant signal only shall be provided for a high-speed route, and when "clear" it shall mean that all high-speed home signals along that route through the interlocking plant, including the home block signal, are "clear."

(11) That every movement within the limits of an interlocking plant shall be governed by an interlocked signal.

*TELEGRAPH, AND CONTROLLED MANUAL, BLOCK SIGNALS.

RECOMMENDED PRACTICE.

(1) The best location for the Telegraph, and Controlled Manual, Block Signal is on a mast alongside and to the right of the track on which are run the trains that it governs, as shown in Fig. 11; but, in the case of more than two tracks, when it is impracticable to spread them apart for this purpose, then the best location is on a bracket post, as in Fig. 12, or on a bridge over the tracks, as in Fig. 13.

(2) It is good practice to make use of the electric slot to send the block signal to normal position, "Stop," as the train passes.

(3) The best "Arm" for the "Telegraph" and "Controlled Manual Block Signal" to be recommended as standard by the Association is the one illustrated in Figs. 5, 6 and 7.

(4) The plan for "Leadout, Pipe-runs and Signal Connections," shown in Fig. 14, is recommended as good practice.

* Adopted, Vol. 6, 1905, pp. 518, 527, 550-551.

RECOMMENDED STANDARD LOCATION OF TELEGRAPH BLOCK SIGNALS.

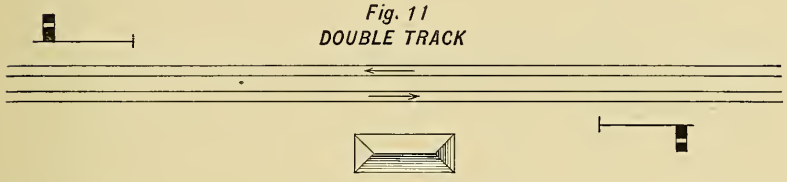


Fig. 11
DOUBLE TRACK

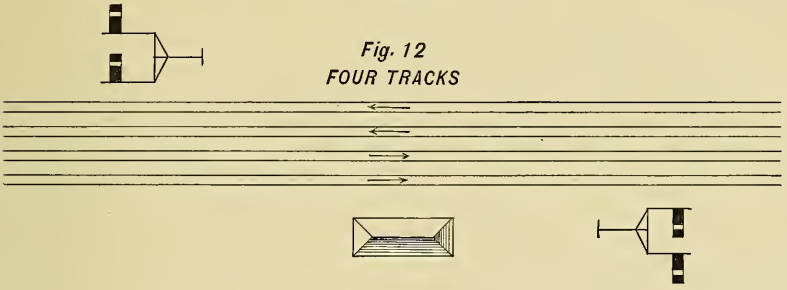


Fig. 12
FOUR TRACKS

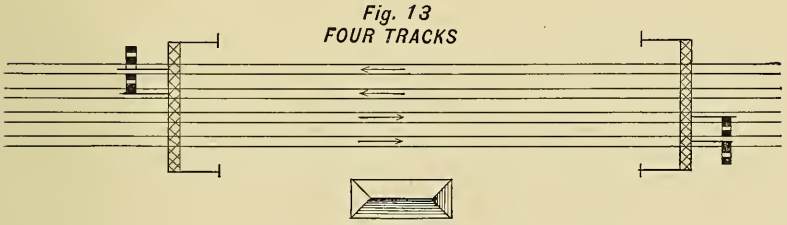


Fig. 13
FOUR TRACKS

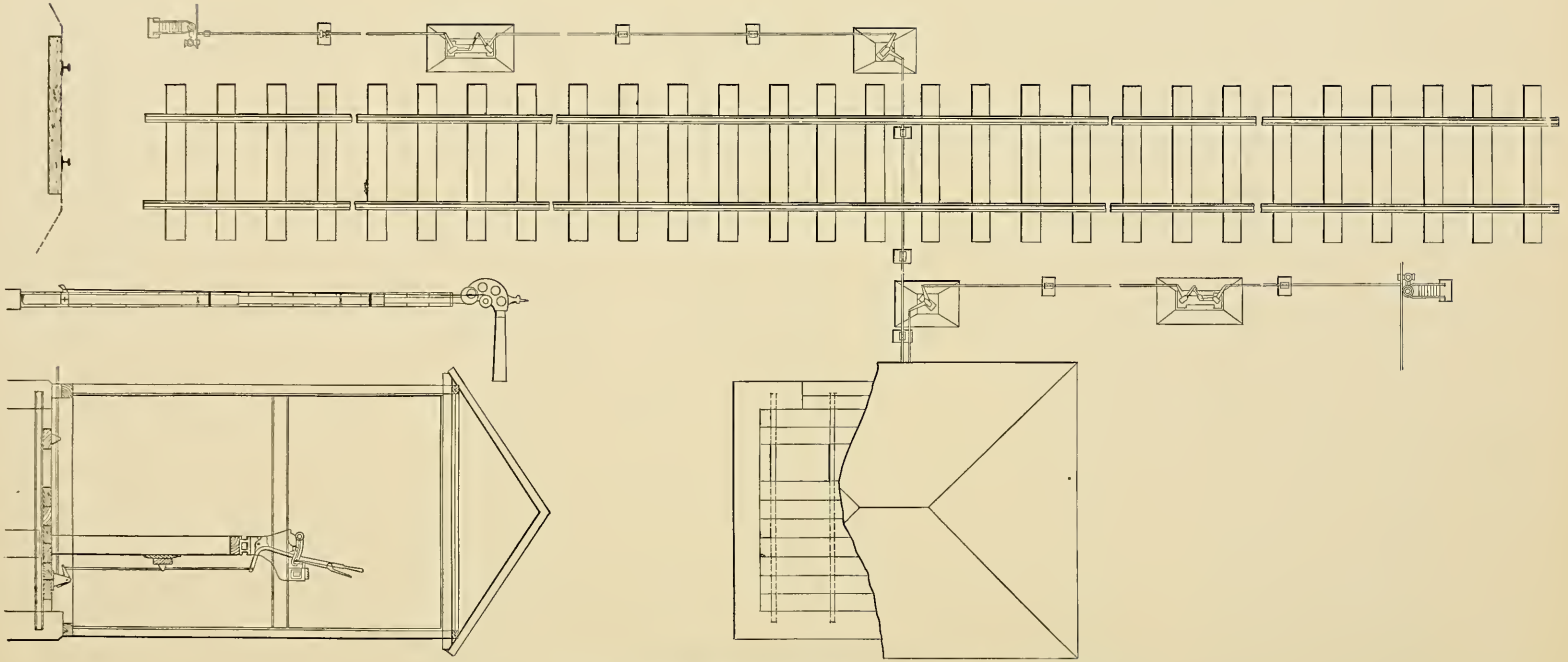


FIG. 14.—Leadout and Pipe Runs for Telegraph Block Signal.

COMMITTEE No. XI.

RECORDS, REPORTS AND ACCOUNTS.

*RECORDS, REPORTS AND ACCOUNTS.

DEFINITIONS.

RECORDS.—Records consist of information or data in graphical, tabular or statement form, relating to the physical characteristics, conditions, cost and such other information as may seem desirable for record.

REPORTS.—Reports consist of the medium through which information is transmitted from a subordinate official to a higher official and from which records and accounts are prepared or compiled in the filing office.

ACCOUNTS.—Accounts cover all statements required to enable payments to be made for labor performed and material furnished and all statements necessary in order to establish the detail, total and comparative cost of work and various classes of expenses.

†FILING DUPLICATE RECORDS IN SEPARATE LOCALITIES FOR PROTECTION IN CASE OF FIRE.

RECOMMENDED PRACTICE.

Duplicate copies of Record Books and maps, particularly right-of-way maps, should be kept in quite widely separated localities, so that the trouble and expense of reproducing the same will be greatly reduced in case of fire or accident.

‡BRIDGE DEPARTMENT FORMS.

CONCLUSIONS AND RECOMMENDED STANDARD FORMS.

(1) The following standard forms are considered essential and recommended as the special forms for a regular working Maintenance of Way Bridge Department:

Report of Foreman of Bridges.....M. W. 1000
Monthly Bridge Material Report.....M. W. 1001

* Adopted, Vol. 5, 1904, pp. 229, 242, 286, 375; Vol. 6, 1905, pp. 657, 668.
† Adopted, Vol. 5, 1904, pp. 286, 371, 377 (see Vol. 2, 1901, p. 322); Vol. 6, 1905, pp. 658, 668.
‡ Adopted, Vol. 5, 1904, pp. 237, 238, 372-375; Vol. 6, 1905, pp. 656, 657, 668.

Foreman's Diary, Bridge Department.....M. W. 1002
Bridge Department Tool Report.....M. W. 1003
Structure Report .....M. W. 1004
Current Bridge Inspection Report.....M. W. 1005
Summary Current Bridge Inspection Report.....M. W. 1006
General Bridge Inspection Report.....M. W. 1007

(2) In Bridge Inspection there should be a clear distinction made between Current Inspection and General Inspection. The purpose of the Current Inspection is to keep the structure in safe condition, to promptly discover any defects and to report the same promptly, so that repairs can be made before the safety of the structure is affected. It is important that a simple record should be made while at the bridge and that the superior officer be kept advised of all such inspections promptly, whether made by a Bridge Mechanic, Gang Foreman, Division Bridge Inspector, Master Carpenter or others.

The purpose of the General Inspection, frequently called the annual inspection, although in many cases conducted semi-annually or even quarterly, is not only to check the maintenance work of the division organization, but to make a more careful investigation of important bridges and structures on the entire road, and, further, to ascertain and settle what extensive repair work or renewal work should be done in the following working season.

(3) The general forms of the railroad should be used in all departments, including Bridge Department, as far as applicable, for example, one form for reporting time should be used in all departments, the form being designed accordingly.

(4) Bridge records, when properly kept up to date in an accurate manner, will prove of the highest value to railroads and are essential for any system of complete and proper bridge records. However, forms in connection with bridge records are not specially necessary for a Bridge Department, but are necessary generally for the compilation of records for several departments, and hence these forms are not recommended as standard special Bridge Department forms.

(5) Numerous minor special forms are used on all railroads for reporting information necessary to keep bridge records up to date, but such forms should be regulated by each individual railroad, according to its peculiar requirements, and hence no standard forms for this purpose are recommended.

Size 3½ x 5½ inches.
Form M. W. 1000.

A. B. & C. R. R. Co.

REPORT OF FOREMAN OF BRIDGES

Master Carpenter, _____ *Station.*

_____ *190*

Dear Sir:—I have completed the following work:

I moved my gang on _____ *(date)* *and began following work:*

Respectfully,

_____

Foreman of Bridges.

SPECIFICATIONS FOR FORM M. W. 1000.

Form as here shown. Size 3½x5½ inches. To be printed on heavy manila paper. On address side, address of Master Carpenter to be printed.

Size 8x13 inches. Form M. W. 1001.

A. B. & C. R. R. Co.

_____ Division

MONTHLY BRIDGE MATERIAL REPORT

_____ Month of _____ 190

(Gang or District.)

KIND OF MATERIAL	UNIT	ON HAND FIRST OF MONTH	RECEIVED	DISPOSED OF		ON HAND END OF MONTH	REMARKS
				USED	SHIPPED AWAY		
2.″0	0.″5	0.″7	0.″7	0.″7	0.′7	0.″7	2.″0
THREE SPACES PER INCH							

The above statement is correct:

.....
Foreman of Bridges.

Correct:.....
Master Carpenter

Form M. W. 1001.

A. B. & C. R. R. Co.

....
(Gang or Dist.)

.....Division

MONTHLY
BRIDGE MATERIAL REPORT

For.....Ending.....190..

Foremen are required to make the above report.....and forward same to Master Carpenter, who will, after examining, approve it and forward to Division Engineer.

To be filed in the office of Division Engineer.

SPECIFICATIONS FOR FORM M. W. 1001.

Form as here shown. Size 8x13 inches. Vertical lines, red; horizontal lines, blue.

SPECIFICATIONS FOR FORM M. W. 1002.

FOREMAN'S DIARY—BRIDGE DEPARTMENT.

To be issued in book form. Size of pages, 5¼x8 inches. Size of book, 5½x8½ inches.

A. B. & C. RAILROAD COMPANY

_____

(Gang or District.)

_____ Division.

FOREMAN'S DIARY.

BRIDGE DEPARTMENT.

Month of _____ _____ 190__

_____

Foreman of Bridges.

I certify that I have examined the within account of Material used on each job, and find it correct.

_____

Master Carpenter.

INSTRUCTIONS TO FOREMEN.

This Diary to be kept by Foreman of Bridges and sent to Master Carpenter and by latter sent to Division Engineer.

In entering in this Diary material used on different jobs you will be governed by the following rules, namely:

Enter the location, name and description of job by giving No. of each bridge or culvert in the column provided for that purpose.

Enter No. or size and name of articles used on each job in proper column, stating quantity, old or new; in case of lumber, give kind (oak, white or yellow pine, etc.).

Always show whether work is complete or not complete in column provided for that purpose. Job should not be noted as "Complete" before all labor as well as material is expended. If a job is complete with labor and without material, Diary should show the job and opposite it notation should be made "No material."

Material must be reported by the correct name.

Columns headed "Charge," "Price" and "Amount" should not be used by mechanics, but should be filled out in Division Engineer's office.

This book should be sent forward promptly at the end of each month.

Show where material was taken from—Stock or Storehouse. If from Storehouse, give name of same.

Enter weight or measure of articles used on the job in columns headed "Quantity," as follows:

ACCOUNT OF MATERIAL

During the month of.....190

Date.	LOCATION, NAME AND DESCRIPTION OF WORK	Completed or not Completed	CHARGE		CR.
			Acct. No.	District	Class No.
← 3/4" →	← 2 3/4" →	← 9/16" →	← 1/4" →	← 7/16" →	← 3/8" →

THREE SPACES PER INCH

USED ON EACH JOB

By ..... Foreman of Bridges.

MATERIAL						
Number Articles	DESCRIPTION	Size	Quantity	Price	Amount	
11/16"	1 7/8"	3/4"	9/16"	3/8"	7/16"	7/16"

Size 8 x 13 inches

Form M. W. 1003.

A. B. & C. R. R. Co.

BRIDGE DEPARTMENT TOOL REPORT

(Gang or District)

_____ Division. For _____ ending _____ 190

TOOLS	ON HAND ___ 1ST	RECEIVED	SENT TO SHOP FOR REPAIRS	BROKEN OR WORN OUT	ON HAND	TOOLS	ON HAND ___ 1ST	RECEIVED	SENT TO SHOP FOR REPAIRS	BROKEN OR WORN OUT	ON HAND
← 1.″5 →	0.″5	0.″5	0.″5	0.″5	0.″5	← 1.″5 →	0.″5	0.″5	0.″5	0.″5	0.″5

THREE SPACES PER INCH

The above statement is correct:

_____ Foreman of Bridges.

Correct: _____ Master Carpenter

Form M. W. 1003.

A. B. & C. R. R. Co.

.....
(Gang or Dist.)

..... Division

BRIDGE DEPARTMENT TOOL REPORT

For.....Ending.....190..

Foremen are required to make the above report.....and forward same to Master Carpenter, who will, after examining, approve it and forward to Division Engineer.

To be filed in the office of Division Engineer.

SPECIFICATIONS FOR FORM M. W. 1003.

Form as here shown. Size 8x13 inches. Vertical ruling, red; horizontal ruling, blue.

Size 8 x 13 inches. Form M. W. 1004.

A. B. & C. R. R. Co.

_____ Division

STRUCTURE REPORT

The following material was used _____
(State Location of Structure definitely.)

Work authorized_____ Commenced_____ Finished_____

KIND OF MATERIAL	UNIT	QUANTITY	PRICE	AMOUNT	
4.''2	0.''7	1.''0	0.''5	0.''8	0.''8
THREE SPACES PER INCH					
KIND OF LABOR	HOURS				
OTHER CHARGES					

The above statement is correct:

_____
Division Engr.

Form M. W. 1004.

A. B. & C. R. R. Co.

.....Division

STRUCTURE REPORT

For.....Ending.....190..

SPECIFICATIONS FOR FORM M. W. 1004.

Form as here shown. Size 8x13 inches. Vertical ruling, red; horizontal ruling, blue.

Size 5¼ x 8 inches. Form M. W. 1005.

Report No.

A. B. & C. R. R. CO. Division

CURRENT BRIDGE INSPECTION REPORT

I have to-day inspected

at

and find its condition as follows:

The following work is required to maintain structure in good condition:

The following work must be done to keep the structure safe:

_____

Inspector.

Date,_____190

NOTE.—Make separate report for each bridge or structure inspected. Send report to the_____of the Division. Report by telegraph to the_____ and the Superintendent of the Division all serious defects that require attention.

SPECIFICATIONS FOR FORM M. W. 1005.

CURRENT BRIDGE INSPECTION REPORT.

Form as here shown. Size 5¼x8 inches. All letters black.

Size 8½x13 inches

Form M. W. 1006.

A. B. & C. R. R. CO. _____ Division.

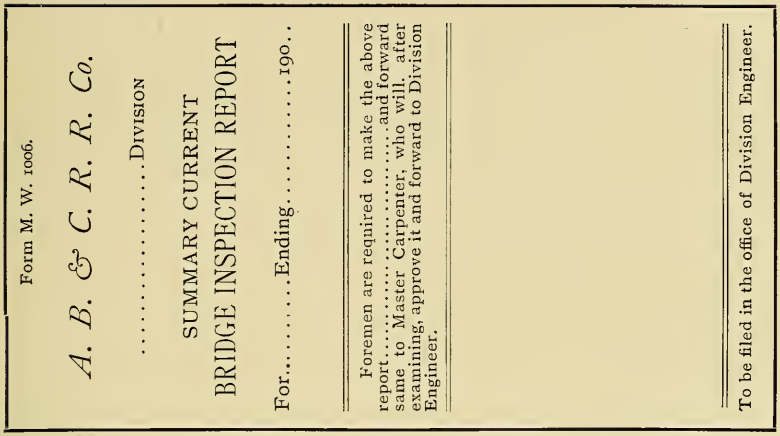
SUMMARY CURRENT BRIDGE INSPECTION REPORT

For _____ 190

Bridge No. or Structure	Kind of Structure	Day of Month Insp't'd	Condition	Action taken or Recommendation

Date _____ 190 _____

NOTE – This report to include all bridges and structures inspected during the period covered by the report.



Form M. W. 1006.

A. B. & C. R. R. Co.

.....Division

SUMMARY CURRENT

BRIDGE INSPECTION REPORT

For.....Ending.....190..

Foremen are required to make the above report.....and forward same to Master Carpenter, who will, after examining, approve it and forward to Division Engineer.

To be filed in the office of Division Engineer.

SPECIFICATIONS FOR FORM M. W. 1006.

Form as here shown. Size 8x13 inches. Vertical ruling, red; horizontal ruling, blue.

Size 11 x 8 inches. Form M. W. 1007.

A. B. & C. R. R. GENERAL BRIDGE

_____Division

From_____ To_____

Bridge No. or Structure	Location	Kind of Structure	Bridge Data	Date Inspected

SPECIFICATIONS FOR FORM M. W. 1007.

Form as here shown. Size of page, 5½x8 inches. To be issued in book form for field use, and on separate sheets for office use. Vertical ruling, red; horizontal, blue.

INSPECTION REPORT.

For_____

Inspected by_____190

General Condition, Description of work required, Recommendations.

*FORMS FOR "GENERAL LABOR REPORT," "MONTHLY TRACK MATERIAL REPORT," "RIGHT-OF-WAY MAPS," "REGISTER OF TITLE DEEDS," AND "CONTRACT AND LEASE RECORD BOOK."

RECOMMENDED STANDARD FORMS.

The "General Labor Report" or "Time Book" form, M. W. 1008, is recommended as a standard form for use by all employés or working gangs in a Maintenance of Way and Structure Department.

The "Monthly Track Material Report" form, M. W. 1009, containing the necessary information for keeping a proper check on material received and used, is recommended as a standard form.

Right-of-Way Maps should be prepared and kept in general in accordance with form M. W. 1010, which is recommended as a standard form for Right-of-Way Maps.

The custodian of deeds should keep a "Register of Title Deeds" in accordance with form M. W. 1011, which is recommended as a standard form for "Register of Title Deeds."

The custodian of leases should keep a "Contract and Lease Record Book" in accordance with form M. W. 1012, which is recommended as a standard form for a "Contract and Lease Record Book."

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*Adopted, Vol. 6, 1905, pp. 634-655, 657-660, 668-673.

Form M. W. 1008.

A. B. & C. R. R. CO.

.....*Division.*

TIME BOOK

—OF—

Section No......

.....*Foreman.*

Headquarters.....

Month of.....*190*....

SPECIFICATIONS.

Size of book, 5x8 inches. Form as shown, cover to be of three-ply manila paper; book proper to be on yellow paper; printing to be in black. Book to contain 12 pages. (Form shown is about one-half reduction.)

INSTRUCTIONS.

1. Enter the information daily.
2. Read the instructions at the bottom of pages 2 and 3.
3. Show under each day the hours of work of each kind done, including work done by Foreman.
4. The Summary on pages 14 and 15 must show all the work done during the month. It is obtained by collecting the work done each day. Show separately work done on main tracks, sidings, new or construction work of all kinds. and for individuals or other companies.
5. The total hours each day must agree with the totals shown on pages 2, 3, 4, 5, 6 and 7.
6. The total of hours in Summary must agree with the total on page 7.

DAILY RECORD OF TIME FOR

NAME	CHECK No.	OCCUPATION	1	2	3	4	5	6	7	8	9	10	11	12	13
TOTAL,															

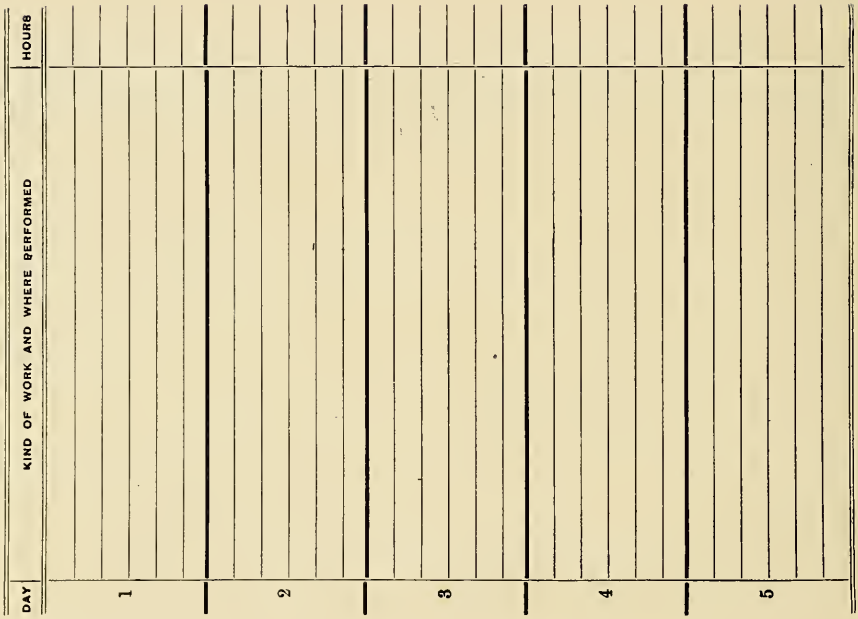
1. Spell names correctly. Write out first name and give middle initial. Enter check number in check number column.
2. Write "Paid by Certificate," when men have been so paid. If hired again, enter name a second time.

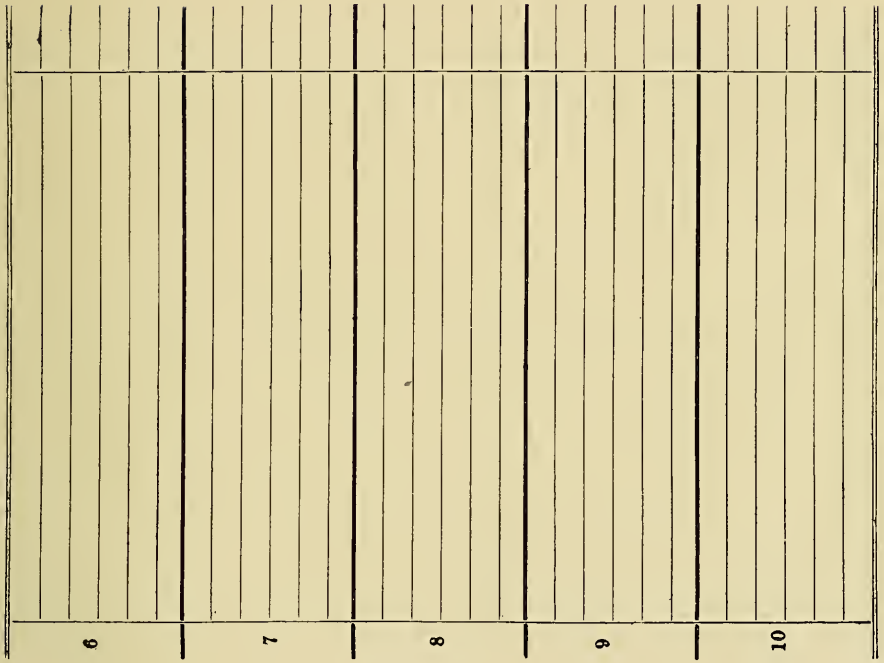
MONTH OF_____190

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL HOURS.	RATE OF PAY. PER MONTH.	RATE OF PAY. PER HOUR.	AMOUNT.	

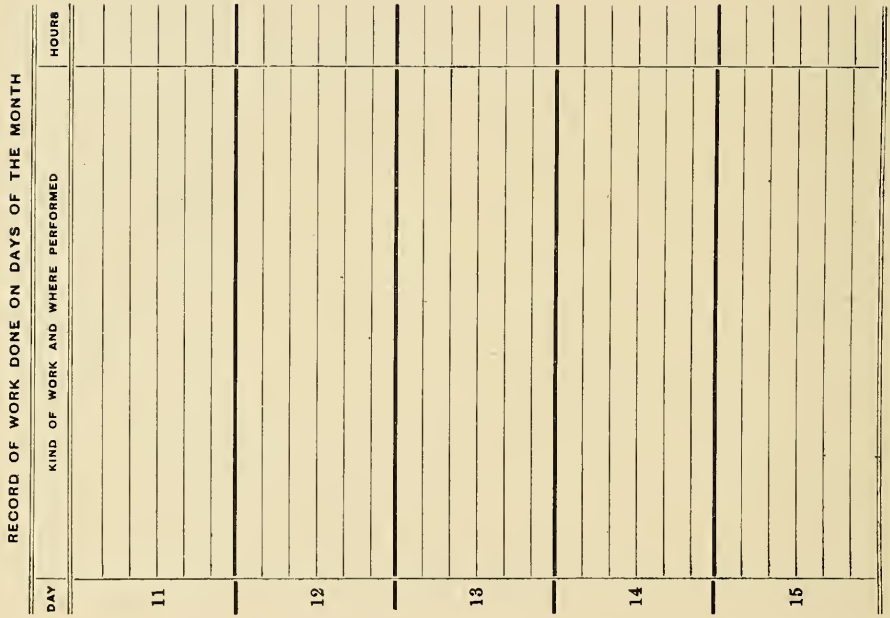
3. Amounts due each man must be in even five (5), or ten (10) cents.
4. Time of monthly men, not working a full month: Multiply the rate per month by the number of days worked (including Sundays and holidays), and divide by the total number of days in the month.

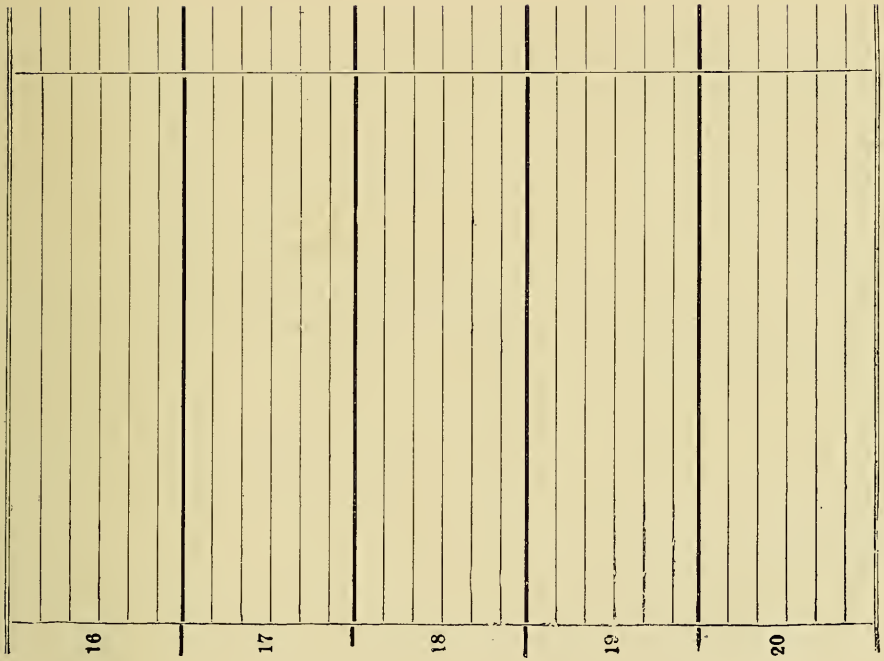
RECORD OF WORK DONE ON DAYS OF THE MONTH





5


RECORD OF WORK DONE ON DAYS OF THE MONTH
DAY
KIND OF WORK AND WHERE PERFORMED
HOURS
11
12
13
14
15

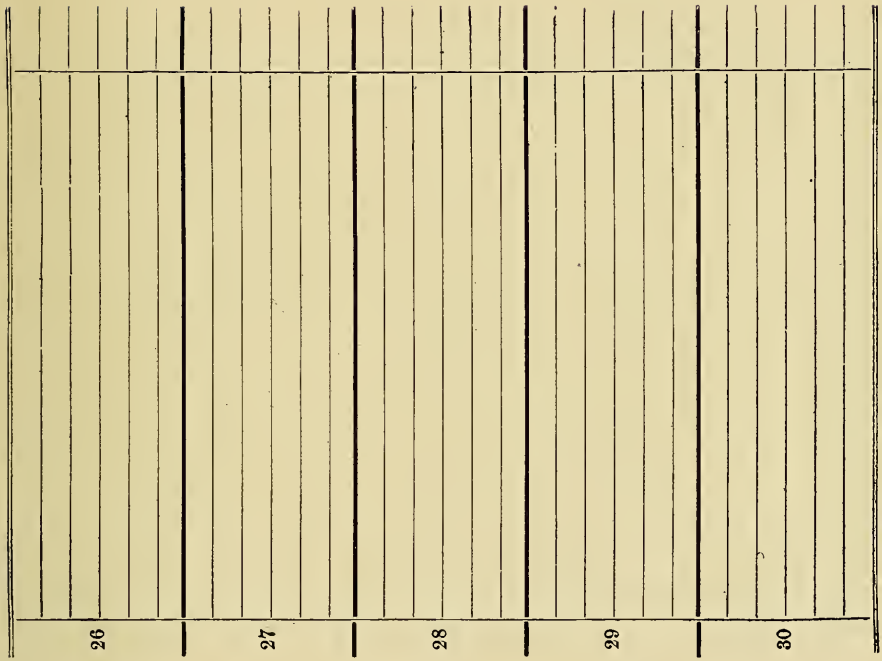


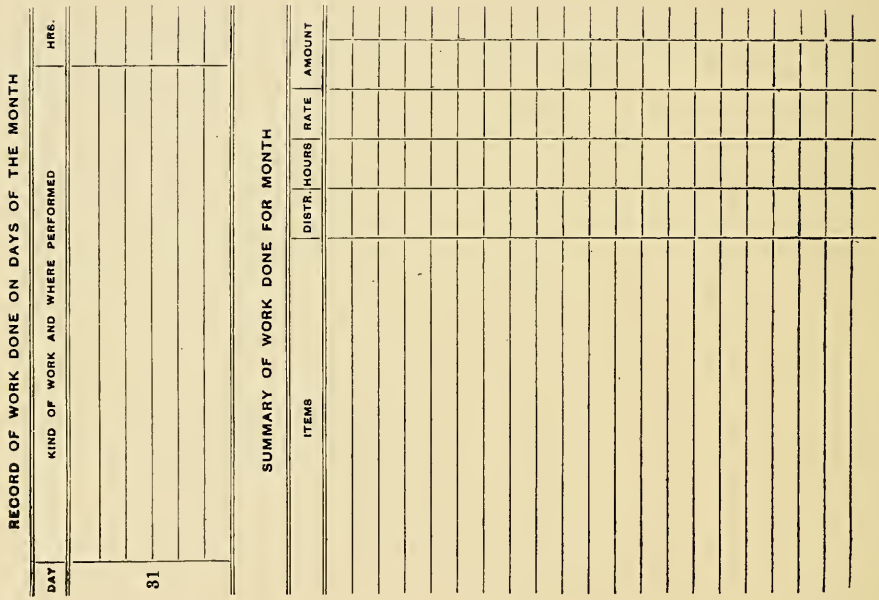
7

8

RECORD OF WORK DONE ON DAYS OF THE MONTH

DAY	KIND OF WORK AND WHERE PERFORMED	HOURS
21		
22		
23		
24		
25		


26
27
28
29
30


RECORD OF WORK DONE ON DAYS OF THE MONTH
DAY
KIND OF WORK AND WHERE PERFORMED
HRS.
31
SUMMARY OF WORK DONE FOR MONTH
ITEMS
DISTR.
HOURS
RATE
AMOUNT

Form M. W. 1009.

A. B. & C. R. R.

MONTHLY TRACK MATERIAL REPORT.

Subdivision_____ Section No._____ For Month Ending_____ 190____

Column Nos. → 1 — Description of Material	2 Unit	3 On Hand at date of last Report	4 Received during the Month: By Shipment	5 Taken Out of Track	6 From Track Taken up	7 Total to Account for	8 Used and Shipped during the Month: Repairs Main Track	9 Repairs Sidings	10 New Tracks	11 New Tracks	12 Shipped Away	13 Total Disposed of	14 On Hand at date of this Report
Rail—new—1st. Class_____ lbs. per yard.	Feet												
" " " " " " "	"												
" " 2nd. Class_____ " " "	"												
" " " " " " "	"												
Rail—relaying—_____ " " "	"												
" " " " " "	"												
" " " " " "	"												
	"												
Scrap Rail—lengths 6ft. and over—lbs. per yard.	"												
" " " " " " "	"												
" " " under 6 ft. " " "	"												
Scrap—Frog—Switch and Guard Rails	"												
Scrap—Miscellaneous track	Pounds												
Cross Ties—1st. Class	Number												
" " " "	"												
" " 2nd. Class	"												
" " " "	"												
Switch Ties—turnout and Crossover—(Fill out space on back.)	Lin'r feet												
Bolts—Track—	Kegs												
" "	"												
R. R. Spikes	"												
" "	"												
Tie Plates—# Intermediate No.____ Joint, No.____	Number												
" " # " "____ "____" ____	"												
" " # " "____ "____" ____	"												
Nut Locks — diameter of hole	"												
" " " " "	"												
Rail Braces #	"												
" " #	"												
" " #	"												
Tie Plugs—	"												
	"												
Angle Bars— weight____ drilling____	Pairs												
" " " "____ "____	"												
" " "____ "____	"												
" " "____ "____	"												
" " "____ "____	"												
" " "____ "____	"												
Angle Bars — Offset — from ____ to ____	"												
" " " "____ "____	"												
" " " "____ "____	"												
Angle Bars — Insulated — weight—# drilling____	"												
" " " " # "	"												
" " " " # "	"												
" " " " # "	"												
Fibre End Posts—weight—	Number												
" " " "	"												

Frogs (Analysis of balance on hand at end of month) — Kind	No.	Weight	New or Old	R.H. or L.H.									
					Number								
					"								
					"								
					"								

Switches (Complete) — Kind	Length	Weight	New or Old										
					"								
					"								
					"								
					"								
					"								
					"								
					"								
					"								

Extra Switch Points (Analysis of balance on hand at end of month)

Slip Switches—weight____ No.____	"												
Guard Rails " ____	"												
" " " ____	"												
Switch Rods—Insulated	"												
" " Plain	"												
Slide Plates—with braces—weight ____ #	"												
" " " " " ____ #	"												
" " plain " ____ #	"												
" " " " ____ #	"												
Switch Stands—Name____ High or Low____	"												
" " " " " "	"												
" " " " " "	"												
Switch Latches	"												
Switch Locks—	"												
Frog and Crossing Bolts	"												
R. R. Crossings—for Crossing____ weight ____ #	"												
Switch Lamps	"												
Signal Lamps	"												
Crossing Plank	Lin'r feet												
Crossing Spikes	Pounds												
Salt	Barrels												
Oil—Headlight	Gallons												
" Signal	"												
" Lubricating	"												
Waste	Pounds												
Pipe—Terra Cotta,—size	Lin'r feet												
" " " "	"												
Iron Pipe "	"												
Fence Posts	Number												
Fence Boards	Ft. B.M.												
Wire Fencing	Rods												
Cattle Guards—Iron____ Wood____	Number												
	"												
	"												

Checked and found correct

_____

Supervisor of Track.

The above account is correct

_____

Section Foreman.

SPECIFICATIONS—Size 14"x17." Form as shown. Ruling: Horizontal—single lines, blue; parallel lines, red; vertical—black or blue.

REMARKS:

Form M. W. 1009.

A. B. & C. R. R.

..........................Division.

MONTHLY TRACK MATERIAL REPORT.

Section No..........................

Month of..............................19....

INSTRUCTIONS.

1. The Section Foreman must keep in a small blank book a daily record of all materials used.

2. He must also keep in the space provided on the back of this blank a daily record of all materials received and shipped.

3. He must close his account on the ......th of each month, and forward the report so as to reach the Supervisor not later than the morning of the ......th of each month.

4. Column No. 14 must show the material actually on hand on the day the report is made.

5. The Supervisor must check the report, sign it and send it to the Division Engineer so as to reach him on the morning of the ......th.

TO BE FILED IN OFFICE OF DIVISION ENGINEER.

Daily Record of Material "Received by Shipment" and "Shipped Away"

Material Received				Material Shipped Away			
Date	Quantity	Description	From Whom Received	Date	Quantity	Description	To Whom Shipped

Number of Sets of Switch Ties on hand at end of Month

	Turn-outs							Cross-overs			Slips		R.R. Cross-ing	
	No. 4	No. 6	No. 8	No. 10	No. 12	No. 14	No.	No. 8	No. 10		No._	No._		
Sets Ties - New														
" " - Old -														
Total Number														

Number and Length of Extra pieces of Switch Ties on hand at end of Month

Lengths	8'9"	9'0"	9'3"	9'6"	9'9"	10'0"	10'3"	10'6"	10'9"	11'0"	11'3"	11'6"	11'9"	12'0"	12'3"	12'6"	12'9"	13'0"	13'3"	13'6"
Number Pieces - New																				
" " - Old																				
Lengths	13'9"	14'0"	14'3"	14'6"	14'9"	15'0"	15'3"	15'6"	15'9"	16'0"	16'3"	16'6"	16'9"	17'0"						21'6"
Number Pieces - New																				
" " - Old																				

Foremen will not fill out the Distribution Column.

I certify the foregoing to be correct,

_____ *Foreman.*

Examined and approved,

_____ *Supervisor.*

A. B. & C. R. R. CO.

RIGHT-OF-WAY MAPS.

365

HENRICI & DUSS, TRUSTEES,
TO
P. & L. E. R. R.,
BEAVER FALLS, BEAVER CO.
W. DEED.

Feb. 6, 1892. Rec. 142-398.
Con. $2,100. Slopes, None.

DESCRIPTION.

Lot 22, 23, 24, b'd n by lots of Darragh, Fetterman and Porter, e by Lincoln alley, s by 17th st, w by 2d ave.

Conditions, None.

366

J. S. DARRAGH ET AL,
TO
P. & L. E. R. R.,
BEAVER FALLS, BEAVER CO.
CON. PRO.

No. 271, June, 1883.
Con., $4,309.28. Slopes, None.

DESCRIPTION.

60 ft. wide through property. Plot shows 30 ft. each side of C. L. from Economy addition to Henrici and Lenz. Being grantors 13-24 undivided interest in same.

Conditions, None.

367

H. W. HARTMAN
TO
P. & L. E. R. R.,
BEAVER FALLS, BEAVER CO.
R. OF W. DEED.

July 10, 1889. Rec. 122-106.
Con., $8,000. Slopes, 2d P., yes.

DESCRIPTION.

First Par.—B'd s by Harmony Society, e by Beaver River, n by Mrs. Metzgar, w by a line 30 ft. and part with N. B. C. L. and in addition so much as shall be necessary for R. of W. for siding to Paper Mill.

Second Par.—60 ft. wide from Paper Mill on s to Harmony Society on n, as shown by plot (no plot attached). Being grantors int. in above parcels.

Conditions.

Not to interfere with dam, right to transmit power under tracks, water wheels, two road crossings, to enlarge culvert, access to dam to repair same, 10 ft. to be reserved by grantee for siding above dam and w of track. Not to extend slopes into river, release of old R. of W. interest of Jas. Darragh.

368.

JAMES DARRAGH
TO
J. M. SCHOONMAKER,
BEAVER FALLS, BEAVER CO.
W. DEED.

Oct. 4, 1894. Rec. 147-233.
Con., $4,500. Slopes, None.

DESCRIPTION.

First Par.—Water lot 6, B'd n by lot 5, e by Beaver River, s by lot 7, w by R. of W. 120 ft. wide, extending to river.

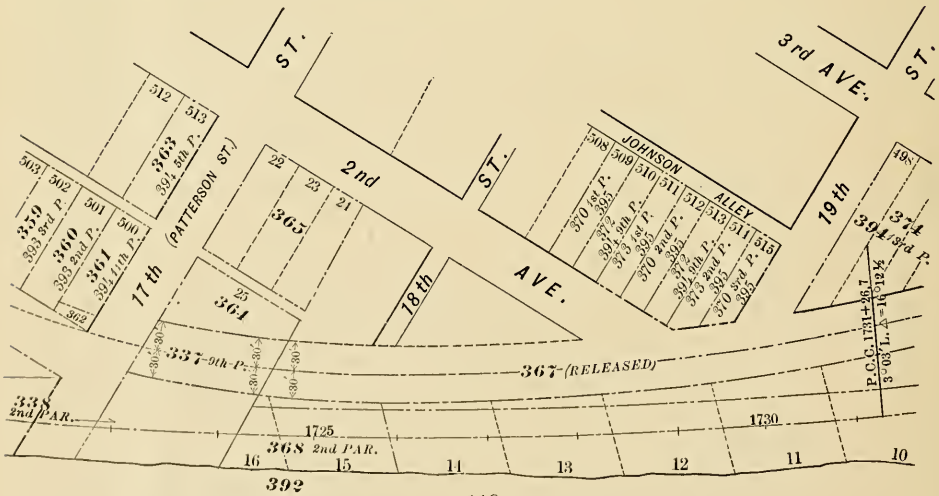
Second Par.—Water lots 15 and 16, B'd n by lot 14, e by Beaver River, s by line of Economy plan, w by R. of W.

Third Par.—Lots 543, 544, 545, B'd n by unnumbered lot, e by Beaver River, s by lot 542, having a front on R. of W. of 1,845 ft.

Fourth Par.—Lots 546, 547, B'd n by lot 548, e by river, s by unnumbered lot, w by R. of W., 123 ft.

Fifth Par.—Unnumbered lot, B'd n by lot 546, e by river, s by lot 545, w by R. of W., 61.5 ft.

Conditions, None.



SPECIFICATIONS FOR FORM M. W. 1010.

RIGHT-OF-WAY MAPS.

Maps showing right-of-way in cities and boroughs should be drawn to a scale of 100 ft. to 1 in. Maps showing right-of-way outside of municipalities may be drawn to a scale of 400 ft. to 1 in. They should be prepared, generally, as shown in the illustration. They should be made in separate sheets for convenient handling, and the width of sheets as a rule should not exceed 18 in. The length of sheets will be determined generally by the size of the printing frame.

Right-of-way sheets may be preserved in one of three ways:

(1) The sheets may be bound together into an atlas.

(2) They may be bound loosely in board covers, so that the sheets may be easily removed and corrected and replaced.

(3) They may be preserved as separate sheets and filed in regular order.

A. B. & C. R. R. CO.

Form M. W. 1011.

MAIN LINE. REGISTER OF TITLE DEEDS. WAYNE COUNTY, MICHIGAN.

No.	Township.	City.	Sub-Div'n.	Sec.	Town'p	Range.	Block.	Lots.	Description.	Grantor.	Grantee.	Date of Conveyance.	Consideration	Length	Width.	Area.	Recorded. B'k	Recorded. Page.	Recorded. Date.	Kind of Deed	Conditions.
												M. D. Y.							M. D. Y.		
41	.....	Detroit	.....	..	..	....	H	16, 17, 18	N. E. Cor. 4th and Front	Catherine H. Jones.	M. C. R. R.	Apr. 16, '47.	$2,300	97.48	60	1.34	31	274 275	Sept. 14, '47.	W.	None.
43	.....	"	.....	..	..	....	H	25-26	North of Front....	J. Halbert and Wife	"	Mar. 5, '47.	600	86.44	40	.79	31	273 274	" " "	W.	"
55	.....	"	.....	..	..	....	K	1-2	S. W. Cor. 4th and Front	Lewis Cass and Wife	"	Sept. 8, '47	19,000	.....	.....	.46	31	278 280	" " "	W.	"
40	Springwells.	"	.....	..	..	....	..	Water Lot 2, 3	Bounded E.'ly by Canal Bank, W. Ann Hunt. N. Woodbridge St., S. by channel....	J. Mullet and Wife	"	Apr. 16, '47.	5,200	400	169.5	1.55	30	112 113 114	Apr. 20, '47.	W.	.....
255	"	"	.....	..	..	....	..	.....	Triangular piece S. E. Cor. 12th and Woodbridge St.....	M. C. R. R.	Fort St. Union D.	Dec. 29, '90.	2,900	250	2.25	....	....	.....	.....	C.	.....
8	"	"	.....	..	..	....	..	.....	Bounded W.'ly by Henry Stanton. E.'ly by Peter Godfrey	Farm'r and Mech Bank J. A. Wells and Wife	M. C. R. R.	Jan. 21, '47.	200	820	140	2.63	29	338-9 340	Jan. 21, '47.	W.	Fences, crossing, gates, etc.
250	"	"	Clarks.	..	..	....	..	120	S. ½ of E. ½ of E. ½ of P. C. 77.....	H. Warren and Wife	"	Apr. 30, '02.	1.00	.....	.....	.063	569	292	May 10, '02.	Q.C	.....
106	Dearborn....	.....	.....	29	2s	10 E	..	.....	W. ½ of N. E. ¼ ..	A. Clay and Wife.....	"	June 1, '72.	75.00	1350	20	0.62	162	270	June 3, '73.	W.	.....
12	Nankin.....	.....	.....	31	2s	9 E	..	.....	W. ½ of S. E. ¼...	C. W. Brink	St. of Mich.	Mar. 3, '41.	1.00	205	100	0.47	20	595-6			R. R. Purposes.
70	"	.....	.....	31	2s	9 E	..	.....	W. ½ of S. W. ¼ ..	Wm. Bell and Wife	M. C. R. R.	Feb. 25, '48.	1.00	1470	100	3.37	32	563	Mar. 3, '43. Mar. 29, '48.	W. W.	.....
33	VanBuren...	.....	.....	5	3s	8E	..	.....	E. ½ of N. W. ¼..	B. Cotton and Wife	"	Jan. 8, '47.	1 00	1270	100	2.92	A	504	Jan. 13, '47.	W.	.....
94	Canton	.....	.....	35	2s	8 E	..	.....	N. of and adj. Rt. of Way in S.W. ¼	L. Sterling and Wife	"	Jan. 10, '59.	1.00	490	228	2.45	76	360	Jan. 22, '59.	W.	R. R. Purposes.

FORM M. W. 1012.

CONTRACT AND LEASE RECORD

CONTRACT AND LEASE RECORD.

Form M. W. 1012

A. B. & C. R. R.

CONTRACTS AND LEASES

100 Pages

Number	Name of Road	With Whom	Nature of Document		Date	Expires	No. of Canceled Contract	Memoranda

RECEIPTS FOR CONTRACTS AND LEASES REMOVED FROM FILES.

RECEIPTS FOR CONTRACTS AND LEASES REMOVED FROM FILES.

50 Pages

Number	Name of Road	With Whom	Receipt	When taken	When returned		Number	Name of Road	With Whom	Receipt	When taken	When returned

REFERENCES TO CONTRACTS AND LEASES, SHOWING DATE OF EXPIRATION

REFERENCES TO CONTRACTS AND LEASES, SHOWING DATE OF EXPIRATION

6 Pages

JANUARY																		FEBRUARY															
1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913		1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913

The Custodian of Leases should keep a Contract and Lease Record Book, containing in the body of the book a full record of the lease in accordance with the form illustrated.
In the back part of the book twelve pages for the twelve months should be ruled into columns for years.
Leases should be numbered and filed in numerical order, by road, branch or division, in a fireproof vault.
Immediately after the receipt of a lease it is entered in the body of the book, the lease number should be entered under the year on the proper month page when it expires.
The names of the lessees should be indexed alphabetically in the front of the book, and each lease should be indexed by the station name.
A few pages in the back of the book should be used for the purpose of keeping a record of the leases removed from the files.

SPECIFICATIONS FOR FORM M. W. 1011.

REGISTER OF TITLE DEEDS.

Form as shown; size of page, 12x28 in.; to be in book form, on heavy white ruled paper; horizontal ruling to be blue; vertical ruling to be red. (Form shown is two-thirds reduction.)

Deeds are filed with the Chief Engineer, the Real Estate Agent, or the Secretary of a railroad company, according to individual practice.

The custodian of deeds should keep a Register of Title Deeds, in accordance with the form illustrated.

Deeds should be numbered consecutively, No. 1, 2, 3, etc., in the order of their receipt by the railroad company; then forwarded to the proper officer to record on right-of-way maps; then returned by the Chief Engineer to the custodian of deeds with notation thereon that the deed has been properly entered, after which all deeds should be filed in numerical order in a fireproof vault.

COMMITTEE NO. XIII.

WATER SERVICE.

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*WATER-SOFTENING METHODS AND PLANTS FOR VARIOUS CONDITIONS.

CONCLUSIONS AND RECOMMENDED PRINCIPLES OF PRACTICE.

(1) All water used in locomotive boilers contains scale-forming matter in solution or suspension, that is the cause of much trouble and expense in operating and maintaining locomotives.

(2) In locating water stations along a railroad, an investigation should be made of all the available water supplies, and care should be taken to avoid the use of poor water, or to curtail its use as much as possible.

(3) If hard water is used, the hardness should be removed before it is put into locomotive boilers.

(4) Hard water can be softened by treating it with chemicals. The chemicals generally used are lime and soda ash.

(5) The chemical method of softening water, commonly used to-day, has been known for many years.

(6) The mechanical methods of modern water-softeners are new and differ widely.

(7) Water, whose hardness is due to carbonates of lime and magnesia, can be softened by the use of lime alone, without adding any soluble salts to the softened water.

(8) Water, whose hardness is due to sulphates of lime and magnesia, can be softened by the use of soda ash, but in this case soluble sulphate of soda will be added to the softened water.

(9) A water-softening method best adapted to any condition can be determined only after a study of that condition.

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*Adopted, Vol. 6, 1905, pp. 601, 622-625.

*COMPARISON OF THE COST OF INSTALLING AND OPERATING WATER-SOFTENING PLANTS, WITH THE BENEFITS DERIVED FROM THEIR USE.

CONCLUSIONS AND RECOMMENDED PRINCIPLES OF PRACTICE.

(1) The cost of installing a water-softening plant varies according to the capacity of the plant, its type, cost of material and labor in its locality, and other local conditions.

(2) The cost of operating a water-softening plant varies according to the efficiency of the water-softening apparatus and the cost of lime and soda ash, or other chemicals available for softening water, in its locality.

(3) The cost of chemicals required to soften water varies according to the quantity of hardening matter in the water, and also its composition.

(4) If the hardening matter consists of carbonates of lime and magnesia, the cost of chemicals for softening the water will be very little, because common lime is the only chemical required.

(5) If the hardening matter consists of sulphates of lime and magnesia, the cost will be higher, because it will be necessary to use soda ash, or some more expensive chemical.

(6) The average cost for chemicals and labor on the Atchison, Topeka & Santa Fe Railway was 2.8 cents per 1,000 gallons; on the Chicago & Northwestern Railway it was 1.8 cents per 1,000 gallons; on the Southern Pacific Lines the average cost for chemicals only was 4.4 cents per 1,000 gallons, and on the Union Pacific it was 1.3 cents per 1,000 gallons.

(7) The benefits derived from water-softening plants are:

Fewer boiler failures due to leaking.

Longer life of flues and firebox sheets.

Reduced cost of labor for repairing and washing boilers.

Increased locomotive mileage between shoppings.

Increased ton mileage per pound of coal consumed.

Decreased number of locomotives in service.

Shorter time required for locomotives to go over the road.

Better feeling among the men, due to fewer failures and shorter time on the road.

Less expense in cost of overtime and delayed time.

*Adopted, Vol. 6, 1905, pp. 607, 608, 611, 625, 626.

*GENERAL CONDITIONS UNDER WHICH THE INSTALLATION OF A WATER-SOFTENING PLANT WOULD PRODUCE SAVINGS.

CONCLUSIONS AND RECOMMENDED PRINCIPLES OF PRACTICE.

(1) If a railroad runs through a region where hard water is the cause of trouble and expense, it would undoubtedly benefit that railroad to install water-softening plants. The actual benefits obtained from water-softening plants as shown in reports obtained from five railroad companies are evidences of this.

(2) If a railroad has increased the size of its locomotives and found that it has more boiler troubles due to hard water than it had with the smaller locomotives, it would be a benefit to install water-softening plants.

(3) It may be a benefit to soften any water used in locomotive boilers that contains 15 or more grains per gallon of hardening matter, or even less than 15 grains, if the hardening matter consists largely of sulphate of lime.

(4) It would not be of much benefit to soften a water that contains 50 grains per gallon of alkali salts before treatment, and also a considerable quantity of sulphate of lime, if soda ash is used to reduce the sulphate of lime, for, although the water can be softened so that it will not make scale, yet it will cause trouble from foaming.

*Adopted, Vol. 6, 1905, pp. 610, 611, 626-628.

COMMITTEE NO. XIV.

YARDS AND TERMINALS.

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*YARDS AND TERMINALS.

DEFINITIONS.

TERMINALS:

† TERMINAL.—The facilities provided by a railway at a terminus or an intermediate point on its line for the purpose of handling its business.

FREIGHT TERMINAL.—The arrangement of terminal facilities for the handling of freight business.

PASSENGER TERMINAL.—The arrangement of terminal facilities for the handling of passenger business.

YARDS:

† YARD.—A system of tracks arranged in series, within defined limits, provided for separating and making up trains, storing cars, and other purposes. Movements not authorized by time tables or by train orders may be made over these tracks, subject to prescribed signals and regulations.

† RECEIVING YARD.—A yard for receiving incoming trains.

† SEPARATING YARD.—A yard adjoining a receiving yard, in which cars are separated according to district, commodity, or other required order.

† CLASSIFICATION YARD.—A yard adjoining a separating yard, in which cars are classified or grouped in accordance with requirements, preliminary to forwarding in trains.

† DEPARTURE OR FORWARDING YARD.—A yard in which cars are assembled in trains ready for leaving.

STORAGE YARD.—A yard in which cars are held awaiting disposition.

‡ CLUSTER OR GENERAL YARD.—An arrangement of yards in series for the separation, classification, assembling and storage of cars.

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* Adopted, Vol. 2, 1901, pp. 39, 40, 46-59; Vol. 4, 1903, p. 349; Vol. 5, 1904, pp. 221, 224-226; Vol. 6, 1905, pp. 568-570, 575, 592.

† Reported by Committee, but not formally approved by the Association.

*Gravity Yard.—A yard in which the separation or classification of cars is aided by gravity.

*Assisting Grade.—The inclination given to one or more tracks of a yard to facilitate the movement of cars in separating or classifying.

Poling Yard.—A yard in which the movement of cars is produced by the use of a pole or stake operated by an engine on an adjoining parallel track. The movement may be facilitated by an assisting grade.

Summit or Hump Yard.—A yard in which the movement of cars is produced by pushing them over a summit, beyond which they run by gravity. The movement from the base of the summit may be facilitated by an assisting grade.

TRACKS:

Body Track.—Each of the parallel tracks of a yard upon which cars are switched or stored.

Ladder Track.—A track connecting in series the body tracks of a yard.

Lead Track.—An extended track connecting either end of a yard with the main line.

Drill Track.—A track connecting with the ladder track and used for movements in yard switching.

*Open Track.—A body track reserved for movements through a yard.

Running Track.—A track reserved for movements through a cluster or general yard.

Crossover Track.—A track connecting two adjacent tracks.

Special Tracks.—In a typical yard there will be several tracks devoted to special purposes, varying with the local conditions. These will include caboose tracks, scale tracks, coaling tracks, ash-pit tracks, bad-order tracks, repair tracks, icing tracks, feed tracks, stock tracks, transfer tracks, sand tracks, depressed tracks, etc.

*Switching District.—That portion of a railway at a large terminal into which cars are moved and from which they are distributed to the various sidetracks and spurs to freight houses and manufacturing establishments served from this district, by yard or switching engines.

*Rail-and-Water Terminal.—A terminal where freight is transferred from railway cars to vessels (or vice versa).

*Y Track.—A triangular arrangement of tracks used in place of a turntable for turning engines, cars or trains.

* Reported by Committee, but not formally approved by the Association.

*Transfer Slip.—A protected landing place for car floats, with adjustable apron for connecting the tracks of the pier and car float; the outer end of apron is generally suspended by adjustable chains and sometimes assisted by pontoon support.

*Siding or Side-Track.—A long track away from a yard connected with the main or running track at one or both ends and used for the storage or irregular movements of cars or trains.

*Passing Siding.—A special siding usually connected with the main track at both ends, and used to enable trains to pass on single track, or to relieve fast traffic on double track.

*Relief Track.—An extended passing siding, long enough to allow an inferior train to continue running.

*Stub Track.—A short track connected with another at one end only.

*Spur Track.—A stub track, usually leading to and serving an industry, or warehouse, freight house, etc.

*House Track.—A track alongside or entering a freight house and used for cars receiving or delivering freight.

PIERS:

*Lighterage Pier.—An open or covered pier at which freight is loaded directly from cars to vessels (or vice versa).

*Export Pier.—A covered pier in which freight is unloaded and stored, mainly for shipment on ocean or coasting steamers.

*Station Pier.—A covered pier having no rail connections, and where freight is received and delivered by car floats.

*Coal Pier.—An open pier where coal is transferred from cars to vessels or barges.

†YARDS AND TERMINALS.

RECOMMENDED PRACTICE.

The recommendations submitted are considered to embody the general principles to be followed in yard design, although local conditions as to site or operation may frequently necessitate a deviation therefrom.

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* Reported by Committee, but not formally approved by the Association.

† Adopted, Vol. 2, 1901, pp. 43-45; Vol. 3, 1902, pp. 267, 268, 280-288; Vol. 4, 1903, pp. 370-380; Vol. 5, 1904, pp. 182-184, 221-224; Vol. 6, 1905, pp. 570-574, 583, 592-594.

Body Tracks.—These should be spaced 11 ft. 6 in. to 13 ft. centers; and where they are parallel to the main track or other important running track they should be spaced not less than 16 ft. c. to c. from said track.

Ladder Tracks.—These should be spaced not less than 15 ft. c. to c. from any parallel track; and a No. 7 frog is the minimum number recommended for yard use.

Lead Tracks.—For safety the connections of these tracks with the main line should be interlocked; and to facilitate train movements, telegraphic connections should be established in the tower.

Drill Tracks.—These should be so located as to cause minimum interference with other movements.

Open Tracks.—The track selected as the open track should be one that will enable movements to be made from one end of the yard to the other with the greatest possible convenience.

Running Tracks.—These tracks should be provided for movements in either direction to enable yard engines to pass freely from one portion of the cluster or general yard to the other; also for road and yard engines to go to and from the engine house and other points where facilities are located.

Crossover Tracks.—Crossovers should be located at the most convenient points, and where they will least interfere with regular movements.

Caboose Tracks.—These tracks should ordinarily be located between the receiving and departure yards and so arranged that the caboose can readily be pushed thereon from a receiving track and then dropped by gravity to the train departing in the direction from which the caboose has arrived.

Scale Track.—These tracks should be located between the receiving and separating yards.

Coaling, Ash-pit, Sand and Engine Tracks.—These tracks should be located on the route leading to and from the engine house and should provide sufficient storage for the reception of engines by the hostler. They should be so arranged (1) that water, coal and sand can be taken and ashes disposed of in convenient rotation; and (2) that switching engines may clean fires, take coal, water and sand, and pass around waiting engines.

Bad-Order Tracks.—Where cars are classified, one or more of these tracks, easy of access, should be provided for setting off bad-order cars, and from which they can readily be removed to the repair tracks.

Repair Tracks.—These tracks should have a maximum capacity of about 15 cars each, spaced alternately 16 ft. and 24 ft. c. to c., and be connected conveniently with the bad-order tracks.

Icing Tracks.—These should be located between the receiving and separating yards so that the cars to be iced may readily be moved from the receiving to the icing track, and thence to the separating yard.

Cluster (or General Yard).—The main tracks should be located on the outside of the cluster, or general yard, with the engine house situated in the center.

Freight Car Repair Yard.—(See repair tracks.)

Coach Cleaning Yard.—This yard should be located for ready and quick access to and from the station. The tracks should be long enough to accommodate trains without cutting; and should be stub-ended, preferably, with a car cleaner's repair and supply building located at right angles at their ends.

Inbound Freight House.—This house should be of such width as will furnish a reasonable amount of floor space for holding freight (50 ft. is a good average width). Usually not more than two tracks are needed, and these should be provided with platforms to avoid the necessity of spotting cars at the doors of the house.

Outbound Freight House.—In order to decrease trucking at this house it should be narrow (25 ft. is a good average width). It is of advantage to have a number of cars at the house so that all freight can be loaded into the cars direct; it is not advisable to load through more than four cars. Platforms should be provided between tracks to avoid necessity of spotting cars. Where a great number of cars are required the trucking distance will usually be decreased, and trucking through cars will also be avoided by having stub tracks running up to a freight house located at right angles to them; these tracks to be separated by covered platforms leading to the freight house.

Roadways.—Where the freight house is on one side and a wall on the other the minimum width of roadway should be 30 ft.; but where a freight house is on one side and a team track or another freight house is on the other the minimum clear width of roadway should be 40 ft.

Transfer House.—A transfer house should be located at a point where there is a coming together of the traffic and a necessity exists for its consolidation, and where the loaded equipment made empty can be used.

Cluster (or General Yard) at Rail-and-Water Terminals.—This should be so arranged that as trains come in the cars can readily be

switched into the necessary classification and then moved to the proper point without interfering with the other movements.

Piers.—At rail-and-water terminals the piers should be designed with a view to the most efficient, rapid and economical handling of the business, and with a view also to the future development of this business. Care must be taken to give due weight to the special conditions and features of location, traffic, etc., which exist in every case and which render it impossible to lay down any but the most general rules for such piers. In every individual case the length, width, number of tracks, width of platform, details of construction and width of waterway between adjacent piers must be adjusted to best meet conditions as to shape and area of site as well as its relation to its approaches from both land and water, the character and volume of the business, and the manner in which it is to be handled

Covered Lighterage Pier.—When conditions will permit, present practice will generally suggest a length of approximately 600 ft., with two depressed tracks. If the business to be handled over the pier is expected to move quickly the width should be no greater than is necessary to provide temporary storage and shelter for the goods during ordinary detentions while waiting for cars or lighters, preferably about 100 ft. If the movement is expected to be slow and it is necessary to provide storage while waiting for cars or vessels, or for assorting, classifying, inspecting or sale of goods, the width should be increased, but generally not beyond a width of 125 to 160 ft. If the movement is not expected to have a special character, or a mixed business is to be provided for, a compromise width of 125 ft. is suggested. The space between the shed and the outer edge of the pier should be not less than two feet, and the clear width of waterway between piers should be, if possible, not less than four times the width of the largest vessel to be handled.

Open Lighterage Pier.—This should, if possible, have a length of about 600 ft., and the width, number of tracks and the appliances for handling traffic should be adjusted to the particular use to which the pier is to be applied. On long piers, crossovers may be necessary.

For ordinary coarse freight in bulk, such as iron ore, stone, timber and similar products, the width should be from 50 to 80 ft., and there should be four tracks, with crossovers, to facilitate the handling of cars and avoid delay in transferring to or from vessels. If the business is light, or consists principally of heavy or costly products, such as cut stone, machinery, or miscellaneous freight not requiring shelter, a narrow pier of about 35 ft. in width, with two tracks only, is suggested.

Export and Storage Pier.—This should be designed with special reference to the character of the commodities to be handled; whether quick movement is expected or the goods are to be held some time in storage for the accumulation of full cargoes, or for inspection or classification. There should be two tracks in a depressed pit on the pier level, which, on long piers, should be properly connected by crossovers at convenient intervals to facilitate the movement of cars. On very wide piers additional tracks on the pier level are desirable under certain conditions. Where the water front is limited or very valuable and the conditions, volume and character of business warrant, pier sheds of two or more stories, with platform or barrel elevators and bag or barrel chutes are used. Under certain conditions additional tracks in the second story may prove more advantageous than elevators. The length should be sufficient to properly accommodate either one or two vessels on each side at the same time, or approximately 600 to 1,400 ft. The width must be determined by the space available and the business to be handled. If quick moving, a width of 125 to 150 ft. is recommended. If slow moving, and large accumulations must be received and stored, the width may be extended, if space permits, to 300 or even 400 ft., but excessive width is not recommended on account of the consequent increase in cost of handling. The space between shed and face of pier should not be less than three nor more than six feet, and the clear waterway between piers should be, if possible, not less than four times the width of the largest vessels to be handled.

Coal Pier.—This should be an open pier, and where coal is to be delivered to vessels through pockets and chutes in the ordinary way, the pier should be high enough to allow coal from drop-bottom cars to be loaded by gravity into vessels or barges. It should have three or more tracks, the outside tracks for loaded cars and the inside one on an incline to return the empty cars to the yard by gravity. The length depends upon the grade necessary to reach the desired elevation, the length of the vessels to be coaled and the number of cars it is desired to unload at one time. Adjacent piers should be sufficiently distant to accommodate the class of service, which will depend on the length of the pier and the size of the water craft to be accommodated. Where coal cars are dumped by machinery which elevates and tilts the cars a high pier is not necessary, and it may be of any convenient height.

Station Pier.—A city station pier served by car floats should be approximately 600 ft. long and 125 ft. wide, with a depressed driveway in the center 35 ft. wide. It should be a closed pier, with 3-ft. platform out-

side. Adjacent parallel piers should be, if possible, 200 ft. apart in the clear. Along the water street should be a bulkhead, approximately 50 ft. wide, with two-story building, the upper floor being for offices, fruit auction room, etc.

Grain Elevators.—These should be so located that cars can be run into them and loaded or unloaded, the tracks being so located that cars will feed to and from the proper part of the cluster or general yard without interference with other movements. The tracks should be arranged to feed cars in at one end and out at the other. Where this cannot be done, the tracks should be so arranged as to allow shifts of cars to be made without stopping all work.

*RATING THE CAR STANDING CAPACITY OF TRACKS.

RECOMMENDED PRACTICE.

Forty (40) linear ft. of track per car seems to be the universally recognized rule for distance assumed in rating car standing capacity of freight yard tracks. No other distance has been suggested, and hence your Committee feels safe in recommending 40 ft. as good practice.

†FREIGHT-CAR REPAIR YARDS.

CONCLUSIONS AND RECOMMENDED PRACTICE.

Heavy car repair tracks should be under cover, and provided with overhead cranes, to facilitate heavy lifting. They should preferably be short, of a capacity of ten to twenty cars each and arranged in pairs; the tracks of each pair should be spaced 16 ft. centers, and the pairs themselves 40 ft. centers.

For other spacing, as well as additional suggestions, see the accompanying sketches, Figs. 1 to 4.

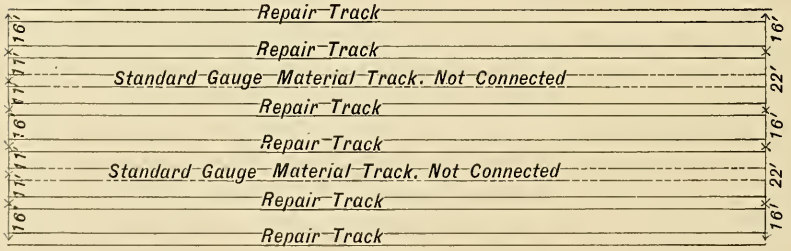

Fig. 1.

*Adopted, Vol. 6, 1905, pp. 579, 594.
†Adopted, Vol. 6, 1905, pp. 579, 580, 594, 595.

FIG 2.

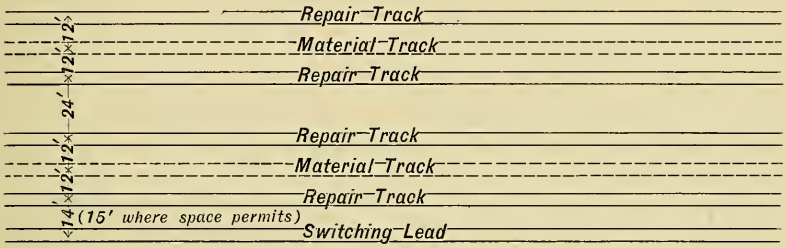

FIG. 3. (HEAVY REPAIRS.)

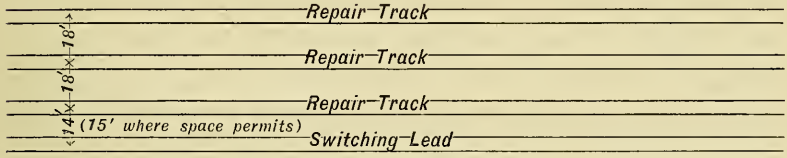

FIG. 4. (LIGHT REPAIRS.)

COMMITTEE NO. XV.

IRON AND STEEL STRUCTURES.

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*INVITING BIDS ON BRIDGE WORK.

RECOMMENDED PRINCIPLES OF PRACTICE.

FIRST.—That it is preferable for railroads to furnish general detail plans and specifications of structural work to bidders, complete enough to show the exact character of the work; but if such plans cannot be furnished, the alternative to be to furnish general specifications, accompanied by outline plans and all information concerning the work.

SECOND.—That it is preferable to invite bids on a pound price basis; and, if desired, alternate bids may be asked for the work, f. o. b. cars, and for the work erected. That a lump sum bid is inadmissible in case an outline plan and specification only is furnished; and that parties other than manufacturers may be invited to bid on the erection.

THIRD.—To invite bids for as large groups of bridges as can be defined consistently with the first recommendation. When required to anticipate future requirements, it is not necessary for the railroad to submit designs if the nature of the work is known to the bidder by reason of having previously done work for the railroad or if standard designs of similar structures are submitted to the bidders.

FOURTH.—Wherever a bridge is to be erected on a line where traffic is to be maintained, it is recommended that the work be done by the railroad force; but on small railroads where suitably organized and equipped forces for such work may not be justified, the large bridges, and in some cases all bridges, may be erected by contract.

FIFTH.—That the railroad company shall in all cases furnish the floor timber.

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*Adopted, Vol. 3, 1902, pp. 227, 228, 253; revised, Vol. 6, 1905, pp. 198, 238, 447, 448.

*GENERAL SPECIFICATIONS FOR MATERIALS AND WORKMANSHIP OF STEEL STRUCTURES.

RECOMMENDED STANDARD SPECIFICATIONS.

I. MATERIAL.

1. Steel shall be made by the open-hearth process. Process of Manufacture.

2. The chemical and physical properties shall conform to the following limits: Schedule of Requirements.

Elements Considered.	Structural Steel.	Rivet Steel.	Steel Castings.
Phosphorus, max.... Basic	0.04 per cent.	0.04 per cent.	0.05 per cent.
Phosphorus, max.... Acid	0.08 "	0.04 "	0.08 "
Sulphur, maximum	0.05 "	0.04 "	0.05 "
Ultimate tensile strength. Pounds per square inch	Desired 60,000 1,500,000*	Desired 50,000 1,500,000	Not less than 65,000
Elong., min. % in 8", Fig. 1	Ult. tensile str'gth 22	Ult. tensile str'gth	18
" " " 2", " 2			
Character of Fracture	Silky	Silky	Silky or fine granular
Cold Bends without Fracture	180° flat†	180° flat‡	90° d = 3t

*See paragraph 11. †See paragraphs 12, 13 and 14. ‡See paragraph 15.

The yield point, as indicated by the drop of beam, shall be recorded in the test reports.

3. If the ultimate strength varies more than 4,000 lbs. from that desired, a retest shall be made on the same gage, which, to be acceptable, shall be within 5,000 lbs. of the desired ultimate. Allowable Variations.

4. Chemical determinations of the percentages of carbon, phosphorus, sulphur and manganese shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt of steel, and a correct copy of such analysis shall be furnished to the engineer or his inspector. Check analyses shall be made from finished material, if called for by the purchaser, in which case an excess of 25 per cent. above the required limits will be allowed. Chemical Analyses.

5. PLATES, SHAPES AND BARS: Specimens for tensile and bending tests for plates, shapes and bars shall be made by cutting coupons from Form of Specimens.

*Adopted, Vol. 4, 1903, pp. 130-137, 141, 142, 253-279; paragraphs 2, 9, 13, 16 and 33 revised, Vol. 5, 1904, pp. 581-583; paragraphs 2, 3, 11, 23, 33, 52, 53, 74, revised, and paragraphs 24, 25, 60, added, Vol. 6, 1905, pp. 228-237, 239, 448-455, 481.

the finished product, which shall have both faces rolled and both edges milled to the form shown by Fig. 1; or with both edges parallel; or they may be turned to a diameter of ¾-in. for a length of at least 9 in., with enlarged ends.

6. Rivets: Rivet rods shall be tested as rolled.

7. Pins and Rollers: Specimens shall be cut from the finished rolled or forged bar, in such manner that the center of the specimen shall

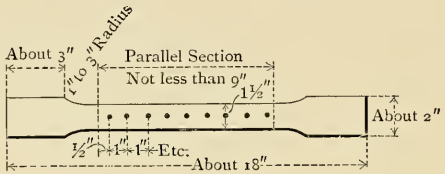


Fig. 1.

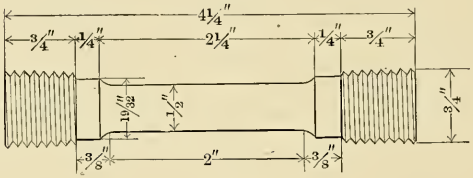


Fig. 2.

be 1 in. from the surface of the bar. The specimen for tensile test shall be turned to the form shown by Fig. 2. The specimen for bending test shall be 1 in. by ½-in. in section.

8. Steel Castings: The number of tests will depend on the character and importance of the castings. Specimens shall be cut cold from coupons molded and cast on some portion of one or more castings from each melt or from the sink heads, if the heads are of sufficient size. The coupon or sink head, so used, shall be annealed with the casting before it is cut off. Test specimens to be of the form prescribed for pins and rollers.

Annealed Specimens.

9. Material which is to be used without annealing or further treatment shall be tested in the condition in which it comes from the rolls. When material is to be annealed, or otherwise treated before use, the specimens for tensile tests representing such material shall be cut from properly annealed or similarly treated short lengths of the full section of the bar.

Number of Tests.

10. At least one tensile and one bending test shall be made from each melt of steel as rolled. In case steel differing ⅜-in. and more in

thickness is rolled from one melt, a test shall be made from the thickest and thinnest material rolled.

Modifications in Elongation.

11. For material less than $\frac{5}{16}$-in. and more than $\frac{3}{4}$-in. in thickness the following modifications will be allowed in the requirements for elongation:

(a) For each $\frac{1}{16}$-in. in thickness below $\frac{5}{16}$-in., a deduction of 2½ will be allowed from the specified percentage.

(b) For each $\frac{1}{8}$-in. in thickness above $\frac{3}{4}$-in., a deduction of 1 will be allowed from the specified percentage.

(c) For pins and rollers over 3 in. in diameter the elongation in 8 in. may be 5 per cent. less than that specified in paragraph 2.

Bending Tests.

12. Bending tests may be made by pressure or by blows. Plates, shapes and bars less than 1 in. thick shall bend as called for in paragraph 2.

Thick Material.

13. Full-sized material for eye-bars and other steel 1 in. thick and over, tested as rolled, shall bend cold 180 degrees around a pin, the diameter of which is equal to twice the thickness of the bar, without fracture on the outside of bend.

Bending Angles.

14. Angles $\frac{3}{4}$-in. and less in thickness shall open flat, and angles ½-in. and less in thickness shall bend shut, cold, under blows of a hammer, without sign of fracture. This test will be made only when required by the inspector.

Nicked Bends.

15. Rivet steel, when nicked and bent around a bar of the same diameter as the rivet rod, shall give a gradual break and a fine, silky uniform fracture.

Finish.

16. Finished material shall be free from injurious seams, flaws, cracks, defective edges or other defects, and have a smooth, uniform and workmanlike finish. Plates 36 in. in width and under shall have rolled edges.

Stamping.

17. Every finished piece of steel shall have the melt number and name of the manufacturer stamped or rolled upon it. Steel for pins and rollers shall be stamped on the end. Rivet and lattice steel and other small parts may be bundled with the above marks on an attached metal tag.

Defective Material.

18. Material which, subsequent to the above tests at the mills, and its acceptance there, develops weak spots, brittleness, cracks or other imperfections, or is found to have injurious defects, will be rejected at the shop and shall be replaced by the manufacturer at his own cost.

Allowable Variation in Weight.

19. A variation in cross-section or weight of each piece of steel of more than 2½ per cent. from that specified will be sufficient cause for

rejection, except in case of sheared plates, which will be covered by the following permissible variations, which are to apply to single plates:

When Ordered to Weight.

20. Plates 12½ lbs. per square foot or heavier:

(a) Up to 100 in. wide, 2½ per cent. above or below the prescribed weight.

(b) One hundred inches wide and over, 5 per cent. above or below.

21. Plates under 12½ lbs. per square foot:

(a) Up to 75 in. wide, 2½ per cent. above or below.

(b) Seventy-five inches and up to 100 in. wide, 5 per cent. above or 3 per cent. below.

(c) One hundred inches wide and over, 10 per cent. above or 3 per cent. below.

When Ordered to Gage.

22. Plates will be accepted if they measure not more than 0.01 in. below the ordered thickness.

23. An excess over the nominal weight, corresponding to the dimensions on the order, will be allowed for each plate, if not more than that shown in the following table, 1 cu. in. of rolled steel being assumed to weight 0.2833 lb.

Thickness Ordered	Nominal Weights	Width of Plate			
		Up to 75"	75" and up to 100"	100" and up to 115"	Over 115"
¼-inch	10.20 lbs.	10 per cent.	14 per cent.	18 per cent.	.....
5/16 "	12.75 "	8 "	12 "	16 "	.....
3/8 "	15.30 "	7 "	10 "	13 "	17 per cent.
7/16 "	17.85 "	6 "	8 "	10 "	13 "
½ "	20.40 "	5 "	7 "	9 "	12 "
9/16 "	22.95 "	4½ "	6½ "	8½ "	11 "
5/8 "	25.50 "	4 "	6 "	8 "	10 "
Over 5/8 "	.....	3½ "	5 "	6½ "	9 "

II. SPECIAL METALS.

Cast-Iron.

24. Except where chilled iron is specified, castings shall be made of tough gray iron, with sulphur not over 0.10 per cent. They shall be true to pattern, out of wind and free from flaws and excessive shrinkage. If tests are demanded, they shall be made on the "Arbitration Bar" of the American Society for Testing Materials, which is a round bar, 1¼ in. in diameter and 15 in. long. The transverse test shall be made on a supported length of 12 in. with load at middle. The minimum breaking load so applied shall be 2,900 lbs., with a deflection of at least 1/10-in. before rupture.

Wrought-Iron Bars.

25. Wrought-iron shall be double-rolled, tough, fibrous and uniform in character. It shall be thoroughly welded in rolling and be free from

surface defects. When tested in specimens of the form of Fig. 1, or in full-sized pieces of the same length, it shall show an ultimate strength of at least 50,000 lbs. per sq. in., an elongation of at least 18 per cent. in 8 in., with fracture wholly fibrous. Specimens shall bend cold, with the fiber, through 135 degrees, without sign of fracture, around a pin the diameter of which is not over twice the thickness of the piece tested. When nicked and bent, the fracture shall show at least 90 per cent. fibrous.

III. INSPECTION AND TESTING AT THE MILLS.

Copies of Mill Orders.

26. The purchaser shall be furnished complete copies of mill orders, and no material shall be rolled, nor work done, before the purchaser has been notified where the orders have been placed, so that he may arrange for the inspection.

Facilities for Inspection.

27. The manufacturer shall furnish all facilities for inspecting and testing the weight and quality of all material at the mill where it is manufactured. He shall furnish a suitable testing machine for testing the specimens, as well as prepare the pieces for the machine, free of cost.

Access to Mills.

28. When an inspector is furnished by the purchaser to inspect material at the mills, he shall have full access, at all times, to all parts of mills where material to be inspected by him is being manufactured.

IV. WORKMANSHIP.

General.

29. All parts forming a structure shall be built in accordance with approved drawings. The workmanship and finish shall be equal to the best practice in modern bridge works.

Straightening Material.

30. Material shall be thoroughly straightened in the shop, by methods that will not injure it, before being laid off or worked in any way.

Finish.

31. Shearing shall be neatly and accurately done and all portions of the work exposed to view neatly finished.

Size of Rivets.

32. The size of rivets, called for on the plans, shall be understood to mean the actual size of the cold rivet before heating.

Rivet Holes.

33. When general reaming is not required, the diameter of the punch for material not over $\frac{5}{8}$-in. thick shall not be more than $\frac{1}{16}$-in. greater than that of the rivet. The diameter of the die shall not exceed that of the punch by more than one-fourth the thickness of the metal punched. Material over $\frac{5}{8}$-in. thick, except minor details, and all material where general reaming is required, shall be sub-punched and reamed as per paragraph 62, or drilled from the solid. Holes in flanges of rolled beams and channels used in floors of railroad bridges shall be drilled from the solid. Those in webs of same shall be so drilled or sub-punched and reamed.

Punching. 34. Punching shall be accurately done. Slight inaccuracy in the matching of holes may be corrected with reamers. Drifting to enlarge unfair holes will not be allowed. Poor matching of holes will be cause for rejection at the option of the inspector.

Assembling. 35. Riveted members shall have all parts well pinned up and firmly drawn together with bolts before riveting is commenced. Contact surfaces to be painted (see paragraph 66).

Lattice Bars. 36. Lattice bars shall have neatly rounded ends, unless otherwise called for.

Web Stiffeners. 37. Stiffeners shall fit neatly between flanges of girders. Where tight fits are called for, the ends of the stiffeners shall be faced and shall be brought to a true contact bearing with the flange angles.

Splice Plates and Fillers. 38. Web splice plates and fillers under stiffeners shall be cut to fit within $\frac{1}{8}$-in. of flange angles.

Web Plates. 39. Web plates of girders, which have no cover plates, shall be flush with the backs of angles or project above the same not more than $\frac{1}{8}$-in., unless otherwise called for. When web plates are spliced, not more than $\frac{1}{4}$-in. clearance between ends of plates will be allowed.

Connection Angles. 40. Connection angles for floor girders shall be flush with each other and correct as to position and length of girder. In case milling is required after riveting, the removal of more than $\frac{1}{16}$-in. from their thickness will be cause for rejection.

Riveting. 41. Rivets shall be driven by pressure tools wherever possible. Pneumatic hammers shall be used in preference to hand driving.

Rivets. 42. Rivets shall look neat and finished, with heads of approved shape, full and of equal size. They shall be central on shank and grip the assembled pieces firmly. Recupping and calking will not be allowed. Loose, burned or otherwise defective rivets shall be cut out and replaced. In cutting out rivets, great care shall be taken not to injure the adjacent metal. If necessary, they shall be drilled out.

Turned Bolts. 43. Wherever bolts are used in place of rivets which transmit shear, the holes shall be reamed parallel and the bolts turned to a driving fit. A washer not less than $\frac{1}{4}$-in. thick shall be used under nut.

Members to be Straight. 44. The several pieces forming one built member shall be straight and fit closely together, and finished members shall be free from twists, bends or open joints.

Finish of Joints. 45. Abutting joints shall be cut or dressed true and straight and fitted close together, especially where open to view. In compression joints

depending on contact bearing, the surfaces shall be truly faced, so as to have even bearings after they are riveted up complete and when perfectly aligned.

Field Connections.

46. Holes for floor girder connections shall be sub-punched and reamed with twist drills to a steel templet 1 in. thick. Unless otherwise allowed, all other field connections shall be assembled in the shop and the unfair holes reamed; and when so reamed the pieces shall be match-marked before being taken apart.

Eye-Bars.

47. Eye-bars shall be straight and true to size, and shall be free from twists, folds in the neck or head, or any other defect. Heads shall be made by upsetting, rolling or forging. Welding will not be allowed. The form of heads will be determined by the dies in use at the works where the eye-bars are made, if satisfactory to the engineer, but the manufacturer shall guarantee the bars to break in the body with a silky fracture, when tested to rupture. The thickness of head and neck shall not vary more than $\frac{1}{16}$-in. from the thickness of the bar.

Boring Eye-Bars.

48. Before boring, each eye-bar shall be properly annealed and carefully straightened. Pin holes shall be in the center line of bars and in the center of heads. Bars of the same length shall be bored so accurately that, when placed together, pins $\frac{1}{32}$-in. smaller in diameter than the pin holes can be passed through the holes at both ends of the bars at the same time.

Pin Holes.

49. Pin holes shall be bored true to gages, smooth and straight; at right angles to the axis of the member and parallel to each other, unless otherwise called for. Wherever possible, the boring shall be done after the member is riveted up.

Variation in Pin Holes.

50. The distance center to center of pin holes shall be correct within $\frac{1}{32}$-in., and the diameter of the hole not more than $\frac{1}{50}$-in. larger than that of the pin, for pins up to 5-in. diameter, and $\frac{1}{32}$-in. for larger pins.

Pins and Rollers.

51. Pins and rollers shall be accurately turned to gages and shall be straight and smooth and entirely free from flaws.

Pilot Nuts.

52. At least one pilot and driving nut shall be furnished for each size of pin for each structure, and field rivets to the amount of 10 per cent. in excess of the number of each size actually required.

Screw Threads.

53. Screw threads shall make tight fits in the nuts and shall be U. S. standard, except above the diameter of 1⅜-in., when they shall be made with 6 threads per in.

Annealing. 54. Steel, except in minor details, which has been partially heated shall be properly annealed.

Steel Castings. 55. All steel castings shall be annealed.

Welds. 56. Welds in steel will not be allowed.

Bed Plates. 57. Expansion bed plates shall be planed true and smooth. Cast wall plates shall be planed top and bottom. The cut of the planing tool shall correspond with the direction of expansion.

Shipping Details. 58. Pins, nuts, bolts, rivets and other small details shall be boxed or crated.

Weight. 59. The weight of every piece and box shall be marked on it in plain figures.

Finished Weight. 60. Payment for pound price contracts shall be by scale weight. No allowance over 2 per cent. of the total weight of the structure as computed from the plans will be allowed for excess weight.

ADDITIONAL SPECIFICATIONS WHEN GENERAL REAMING AND PLANING ARE REQUIRED.

Planing Edges. 61. Sheared edges and ends shall be planed off at least ¼-in.

Reaming. 62. Punched holes shall be made with a punch $\frac{3}{16}$-in. smaller in diameter than the nominal size of the rivets and shall be reamed to a finished diameter of not more than $\frac{1}{16}$-in. larger than the rivet.

Reaming After Assembling. 63. Wherever practicable, reaming shall be done after the pieces forming one built member have been assembled and firmly bolted together. If necessary to take the pieces apart for shipping and handling, the respective pieces reamed together shall be so marked that they may be reassembled in the same position in the final setting up. No interchange of reamed parts will be allowed.

Removing Burrs. 64. The burrs on all reamed holes shall be removed by a tool countersinking about $\frac{1}{16}$-in.

V. SHOP PAINTING.

Cleaning. 65. Steel work, before leaving the shop, shall be thoroughly cleaned and given one good coating of pure linseed oil, or such paint as may be called for, well worked into all joints and open spaces.

Contact Surfaces. 66. In riveted work, the surfaces coming in contact shall each be painted before being riveted together.

Inaccessible Surfaces.

67. Pieces and parts which are not accessible for painting after erection, including tops of stringers, eye-bar heads, ends of posts and chords, etc., shall have a good coat of paint before leaving the shop.

Condition of Surfaces.

68. Painting shall be done only when the surface of the metal is perfectly dry. It shall not be done in wet or freezing weather, unless protected under cover.

Machine-Finished Surfaces.

69. Machine-finished surfaces shall be coated with white lead and tallow before shipment or before being put out into the open air.

VI. INSPECTION AND TESTING AT THE SHOPS.

Facilities for Inspection.

70. The manufacturer shall furnish all facilities for inspecting and testing the weight and the quality of workmanship at the shop where material is manufactured. He shall furnish a suitable testing machine for testing full-sized members if required.

Starting Work in Shop.

71. The purchaser shall be furnished complete shop plans, and must be notified well in advance of the start of the work in the shop, in order that he may have an inspector on hand to inspect material and workmanship. Complete copies of shipping invoices shall be furnished to the purchaser with each shipment.

Access to Shop.

72. When an inspector is furnished by the purchaser, he shall have full access, at all times, to all parts of the shop where material under his inspection is being manufactured.

Accepting Material or Work.

73. The inspector shall stamp each piece accepted with a private mark. Any piece not so marked may be rejected at any time, and at any stage of the work. If the inspector, through an oversight or otherwise, has accepted material or work which is defective or contrary to the specifications, this material, no matter in what stage of completion, may be rejected by the purchaser.

VII. FULL-SIZED TESTS.

Test to Prove Workmanship and Design.

74. Full-sized parts of structures shall be tested by the manufacturer if required by the purchaser. Such tests on eye-bars and similar members, to prove the workmanship, shall be made at the manufacturer's expense, and shall be paid for by the purchaser, at contract price, if the tests are satisfactory. If the tests are not satisfactory, the members represented by them will be rejected The expense of testing members, to prove their design, shall be paid for by the purchaser.

Eye-Bar Tests.

*75. In eye-bar tests the ultimate strength, true elastic limit and the elongation in 10 ft., unless a different length is called for, shall be recorded.

Transverse Tests.

76. In transverse tests the lateral and vertical deflections shall be recorded.

*An amendment to this paragraph, adopted at the 1905 convention (Vol. 6, p. 239), will be submitted by the Committee for reconsideration at the 1906 convention.

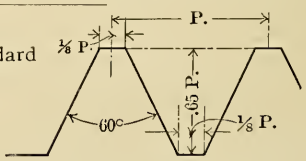
†STANDARD UPSETS.

RECOMMENDED STANDARD TABLE.

STANDARD UPSETS FOR ROUND AND SQUARE BARS.

ROUND BARS.						SQUARE BARS.					
Bar.	Upset.		Bar.	Upset.		Bar.	Upset.		Bar.	Upset.	
Diam. Inches.	Diam. Inches.	Length Inches.	Diam. Inches.	Diam. Inches.	Length Inches.	Side. Inches.	Diam. Inches.	Length Inches.	Side. Inches.	Diam. Inches.	Length Inches.
¾	1	4	2½	3	6	¾	1⅛	4	2⅛	3	6
⅞	1⅛	4	2⅝	3⅛	6½	⅞	1¼	4	2¼	3⅛	6½
1	1⅜	4	2¾	3¼	6½	1	1½	4	2⅜	3⅜	7
1⅛	1½	4	2⅞	3⅜	7	1⅛	1⅝	4½	2½	3½	7
1¼	1⅝	4½	3	3½	7	1¼	1¾	4½	2⅝	3⅝	8
1⅜	1¾	4½	3⅛	3⅝	8	1⅜	2	5	2¾	3⅞	8
1½	1⅞	4½	3¼	3¾	8	1½	2⅛	5	2⅞	4	8
1⅝	2	5	3⅜	3⅞	8	1⅝	2¼	5	3	4⅛	8½
1¾	2⅛	5	3½	4	8	1¾	2½	5½	3⅛	4⅜	9
1⅞	2¼	5	3⅝	4⅛	8½	1⅞	2⅝	5½	3¼	4½	9
2	2⅜	5½	3¾	4¼	8½	2	2⅞	6			
2⅛	2½	5½	3⅞	4⅜	9						
2¼	2¾	5½									
2⅜	2⅞	6									

Shape of thread, U. S. standard



Diameter of screw ends	1″	1⅛″	1¼″	1⅜″ and above.
No. of threads per inch	8	7	7	6

Minimum excess at root of thread over body of bar, 15 per cent.

† Adopted, Vol. 5, 1904, pp. 575, 580.

APPENDIX

ORGANIZATION OF COMMITTEES FOR 1905-1906.

I. ROADWAY.

H. J. Slifer, Contracting Engineer, New York, N. Y., *Chairman.*

R. C. Barnard, Superintendent, Cleveland, Akron & Columbus Railway, Akron, O., *Vice-Chairman.*

G. H. Bremner, Engineer Maintenance of Way, Chicago, Burlington & Quincy Railroad, Chicago, Ill.

J. F. Burns, Roadmaster, Louisville & Nashville Railroad, Elizabethtown, Ky.

F. R. Coates, Contracting Engineer, Chicago, Ill.

C. Dougherty, Superintendent, Illinois Central Railroad, Clinton, Ill.

W. D. Pence, Prof. of Civil Engineering, Purdue University, Lafayette, Ind.

H. Rohwer, Consulting Engineer, Missouri Pacific Railway System, St. Louis, Mo.

A. M. Shaw, Chief Engineer, Northern Illinois Electric Railway, Dixon, Ill.

A. K. Shurtleff, Assistant Engineer, Union Pacific Railroad, Omaha, Neb.

J. G. Sullivan, Assistant Chief Engineer, Isthmian Canal Commission, Culebra, Canal Zone, Panama.

H. M. Waite, Superintendent, Cincinnati, New Orleans & Texas Pacific Railroad, Somerset, Ky.

L. H. Wheaton, Division Engineer, Halifax & Southwestern Railway, Shelburne, N. S.

R. C. Young, Chief Engineer, Lake Superior & Ishpeming Railway, Marquette, Mich.

II. BALLASTING.

John V. Hanna, Assistant Engineer Maintenance of Way, St. Louis & San Francisco Railway, St. Louis, Mo., *Chairman.*

C. A. Paquette, Superintendent, Cleveland, Cincinnati, Chicago & St. Louis Railway, Indianapolis, Ind., *Vice-Chairman.*

C. H. Byers, Assistant Engineer, Pacific Railway, Seattle, Wash.

A. Q. Campbell, Hogansville, Ga.

M. P. Cotton, Assistant Engineer, Canadian Pacific Railway, Lipton, Assin., Can.

L. F. Goodale, Engineer Maintenance of Way, Chicago, Burlington & Quincy Railroad, St. Louis, Mo.

G. D. Hicks, Superintendent, Nashville, Chattanooga & St. Louis Railway, Tullahoma, Tenn.

B. C. Milner, Superintendent, Southern Railway, Louisville, Ky.

J. O. Osgood, Chief Engineer, Central Railroad of New Jersey, Jersey City, N. J.

F. W. Ranno, Terre Haute, Ind.

Samuel Rockwell, Chief Engineer, Lake Shore & Michigan Southern Railway, Cleveland, O.

A. F. Rust, Resident Engineer, Kansas City Southern Railway, Kansas City, Mo.

G. M. Walker, Jr., Assistant Engineer, Kansas City Belt Railway, Kansas City, Mo.

III. TIES.

E. B. Cushing, General Superintendent, Morgan's Louisiana & Texas Railroad, New Orleans, La., *Chairman.*

W. W. Curtis, Consulting Engineer, Chicago, Ill., *Vice-Chairman.*

E. G. Ericson, Prin. Assistant Engineer, N. W. System, Pennsylvania Lines, Pittsburg, Pa.

E. O. Faulkner, Manager Tie and Timber Dept., Santa Fe Railway System, Topeka, Kan.

C. F. W. Felt, Chief Engineer, Gulf, Colorado & Santa Fe Ry., Galveston, Texas.

E. E. Hart, Engineer, New York, Chicago & St. Louis Railway, Cleveland, O.

V. K. Hendricks, Division Engineer, Baltimore & Ohio Railroad, Baltimore, Md.

J. C. Nelson, Roadmaster, Alabama Great Southern Railway, Birmingham, Ala.

S. M. Rowe, Consulting Engineer, Chicago, Ill.

H. R. Safford, Assistant Chief Engineer, Illinois Central Railroad, Chicago, Ill.

Dr. Hermann Von Schrenk, Pathologist, Dept. of Agriculture, St. Louis, Mo.

IV. RAIL.

Wm. R. Webster, Consulting and Inspecting Engineer, Philadelphia, Pa., *Chairman.*

R. Montfort, Consulting Engineer, Louisville & Nashville Railroad, Louisville, Ky., *Vice-Chairman.*

F. E. Abbott, Inspecting Engineer, Lackawanna Steel Company, Buffalo, N. Y.

E. B. Ashby, Engineer Maintenance of Way, Lehigh Valley Railroad, South Bethlehem, Pa.

D. D. Carothers, Chief Engineer, Baltimore & Ohio Railroad System, Baltimore, Md.

S. M. Felton, President, Chicago & Alton Railway, Chicago, Ill.

J. F. Hinckley, Chief Engineer, St. Louis & San Francisco Railway System, St. Louis, Mo.

Robt. W. Hunt, Consulting Engineer, Chicago, Ill.

J. W. Kendrick, Third Vice-President, Atchison, Topeka & Santa Fe Railway System, Chicago, Ill.

E. F. Kenney, Engineer of Tests, Pennsylvania Railroad, Philadelphia, Pa.

J. Kruttschnitt, Director of Maintenance and Operation, Harriman Lines, Chicago, Ill.
D. W. Lum, Chief Engineer Maintenance of Way and Structures, Southern Railway, Washington, D. C.
F. H. McGuigan, Fourth Vice-President, Grand Trunk Railway System, Montreal, Canada.
E. J. Pearson, Chief Engineer, Northern Pacific Railway, St. Paul, Minn.
H. T. Porter, Chief Engineer, Bessemer & Lake Erie Railroad, Greenville, Pa.
J. T. Richards, Chief Engineer Maintenance of Way, Pennsylvania Railroad, Philadelphia, Pa.
R. Trimble, Chief Engineer Maintenance of Way, N. W. System, Pennsylvania Lines, Pittsburg, Pa.
H. U. Wallace, Third Vice-President, J. G. White Co., New York, N. Y.
G. B. Woodworth, Rail Inspector, Chicago, Milwaukee & St. Paul Railway, Chicago, Ill.

V. TRACK.

Garrett Davis, District Engineer, Chicago, Rock Island & Pacific Railway, Cedar Rapids, Ia., *Chairman.*
E. H. Lee, Chief Engineer, Chicago & Western Indiana Railroad, Chicago, Ill., *Vice-Chairman.*
Wm. Ashton, Chief Engineer, Oregon Short Line, Salt Lake City, Utah.
J. R. W. Davis, Engineer Maintenance of Way, Great Northern Railway, St. Paul, Minn.
G. E. Drew, Assistant Engineer, Pere Marquette Railroad, Grand Rapids, Mich.
T. H. Hickey, Roadmaster, Michigan Central Railroad, St. Thomas, Ont.
D. MacPherson, Assistant Chief Engineer, National Transcontinental Railway, Ottawa, Can.
F. L. Nicholson, Engineer Maintenance of Way, Norfolk & Southern Railway, Norfolk, Va.
O. D. Richards, Chief Engineer, Ann Arbor Railroad, Toledo, O.
L. S. Rose, Engineer Maintenance of Way, Cleveland, Cincinnati, Chicago & St. Louis Railway, Mattoon, Ill.
John C. Sesser, Engineer of Construction, Chicago, Burlington & Quincy Railroad, Centralia, Ill.
F. A. Smith, Editor, *Roadmaster and Foreman,* Chicago, Ill.
F. J. Stimson, Engineer Maintenance of Way, Grand Rapids & Indiana Railway, Grand Rapids, Mich.

VI. BUILDINGS.

A. R. Raymer, Assistant Chief Engineer, Pittsburg & Lake Erie Railroad, Pittsburg, Pa., *Chairman.*
E. D. B. Brown, Contracting Engineer, Chicago, Ill., *Vice-Chairman.*
G. F. Bristol, Engineer of Building, Pere Marquette, Railroad, Detroit, Mich.

M. Coburn, Engineer Maintenance of Way, Vandalia Line, Terre Haute, Ind.
H. M. Cryder, Principal Assistant Engineer, Wabash Railroad, St. Louis, Mo.
B. C. Gowen, Chief Engineer, Wisconsin & Michigan Railroad, Peshtigo, Wis.
E. C. Macy, Superintendent, Thos. Phee & Co., St. Croix, Wis.
H. M. Steele, Chief Engineer, Central of Georgia Railway, Savannah, Ga.

VII. WOODEN BRIDGES AND TRESTLES.

F. E. Schall, Bridge Engineer, Lehigh Valley Railroad, South Bethlehem, Pa., *Chairman.*
H. S. Jacoby, Professor of Bridge Engineering, Cornell University, Ithaca, N. Y., *Vice-Chairman.*
F. H. Bainbridge, Principal Assistant Engineer, Chicago & Northwestern Railway, Chicago, Ill.
A. L. Bowman, Consulting Engineer, New York, N. Y.
D. B. Dunn, Assistant Engineer, Seaboard Air Line, Portsmouth, Va.
H. G. Fleming, President and Chief Engineer, Union Belt Railway, Memphis, Tenn.
James Keys, Assistant Engineer, Union Pacific Railroad, Omaha, Neb.
H. B. Merriam, Assistant Engineer, Oregon Short Line, Salt Lake, Utah.
Wm. Michel, Engineer Maintenance of Way, Hocking Valley Railroad, Columbus, O.

VIII. MASONRY.

E. C. Brown, Engineer Maintenance of Way, Union Railroad, Port Perry, Pa., *Chairman.*
John Dean, Civil Engineer, Chicago, Ill., *Vice-Chairman.*
Frank Beckwith, Engineer of Bridges and Structures, Lake Shore & Michigan Southern Railway, Cleveland, O.
C. W. Boynton, Chief Inspector, Cement Dept., Illinois Steel Company, Chicago, Ill.
A. O. Cunningham, Chief Engineer, Wabash Railroad, St. Louis, Mo.
W. B. Hanlon, Civil and Mining Engineer, Cleveland, O.
W. K. Hatt, Professor of Applied Mechanics, Purdue University, Lafayette, Ind.
C. H. Moore, First Assistant Engineer, Erie Railroad, New York, N. Y.
H. W. Parkhurst, Assistant to Engineer of Bridges, Illinois Central Railroad, Chicago, Ill.
J. W. Schaub, Consulting Engineer, Chicago, Ill.
G. H. Scribner, Jr., Contracting Engineer, Chicago, Ill.
G. F. Swain, Professor of Civil Engineering, Mass. Institute of Technology, Boston, Mass.

Job Tuthill, Bridge Engineer, Pere Marquette Railroad, Detroit, Mich.
E. P. Weatherly, Resident Engineer, Chicago, Burlington & Quincy Railroad, St. Joseph, Mo.

IX. SIGNS, FENCES, CROSSINGS AND CATTLE-GUARDS.

W. D. Williams, Chief Engineer, Cincinnati Northern Railroad, Van Wert, O., *Chairman.*
F. P. Gutelius, Engineer Maintenance of Way, Canadian Pacific Railway, Montreal, Canada, *Vice-Chairman.*
F. E. Bissell, First Assistant Engineer, Lake Shore & Michigan Southern Railway, Cleveland, O.
S. B. Fisher, Chief Engineer, Missouri, Kansas & Texas Railway, St. Louis, Mo.
F. G. Jonah, Assistant Engineer, New Orleans Terminal Co., New Orleans, La.
A. G. Norton, Resident Engineer, Erie Railroad, Otisville, N. Y.
H. R. Talcott, Engineer of Surveys, Baltimore & Ohio Railroad, Baltimore, Md.
W. A. Wallace, Division Engineer, Chicago, Indianapolis & Louisville Railroad, Chicago, Ill.
A. A. Wirth, Engineer Maintenance of Way, Pennsylvania Lines West, Pittsburg, Pa.

X. SIGNALING AND INTERLOCKING.

Chas. A. Dunham, Signal Engineer, Great Northern Railway, St. Paul, Minn., *Chairman.*
W. A. D. Short, Signal Engineer, Illinois Central Railroad, Chicago, Ill., *Vice-Chairman.*
C. L. Addison, General Superintendent, Long Island Railroad, Long Island City, N. Y.
F. H. Alfred, Contracting Engineer, Montreal, Canada.
G. E. Ellis, Signal Engineer, Chicago, Rock Island & Pacific Railroad, Chicago, Ill.
H. H. Knowlton, Assistant Engineer, Cleveland, Cincinnati, Chicago & St. Louis Railway, Cincinnati, O.
J. C. Mock, Signal Engineer, Michigan Central Railroad, Detroit, Mich.
J. A. Peabody, Signal Engineer, Chicago & Northwestern Railway, Chicago, Ill.
A. H. Rudd, Assistant Signal Engineer, Pennsylvania Railroad, Philadelphia, Pa.
Thos. S. Stevens, Signal Engineer, Santa Fe Railway System, Topeka, Kan.

XI. RECORDS, REPORTS AND ACCOUNTS.

Edwin F. Wendt, Assistant Engineer, Pittsburg & Lake Erie Railroad, Pittsburg, Pa., *Chairman.*

W. S. Kinnear, Assistant General Manager, Michigan Central Railroad, Detroit, Mich., *Vice-Chairman.*

W. Archer, Engineering Department, Baltimore & Ohio Southwestern Railroad, Cincinnati, O.

J. B. Austin, Jr., Engineer Maintenance of Way, Long Island Railroad, Jamaica, N. Y.

J. G. Bloom, Engineer Maintenance of Way, Chicago, Rock Island & Pacific Railway, Topeka, Kan.

B. T. Elmore, Assistant Chief Engineer, Tidewater Railway, Norfolk, Va.

R. L. Huntley, Chief Engineer, Union Pacific Railroad, Omaha, Neb.

Paul Jones, Superintendent, Cincinnati & Muskingum Valley Railroad, Zanesville, O.

V. D. Simar, Principal Assistant Engineer, Duluth, South Shore & Atlantic Railroad, Marquette, Mich.

J. E. Turk, Superintendent, Philadelphia & Reading Railway, Tamaqua, Pa.

E. K. Woodward, Engineer Maintenance of Way, Wabash Railroad, Peru, Ind.

H. A. Woods, Assistant Chief Engineer, Grand Trunk Pacific Railway, Montreal, Canada.

XII. UNIFORM RULES, ORGANIZATION, TITLES, CODE, ETC.

R. H. Aishton, Assistant General Manager, Chicago & Northwestern Railway, Chicago, Ill., *Chairman.*

G. H. Webb, Chief Engineer, Michigan Central Railroad, Detroit, Mich., *Vice-Chairman.*

J. H. Abbott, Bridge Engineer, Spokane International Railway, Spokane, Wash.

A. S. Baldwin, Chief Engineer, Illinois Central Railroad, Chicago, Ill.

Robert Bell, Superintendent, Pennsylvania Railroad, Buffalo, N. Y.

C. N. Kalk, Chief Engineer, Wisconsin Central Railway, Milwaukee, Wis.

E. L. Peckham, Vice-President and General Manager, Denver, Enid & Gulf Railroad, Enid, Okla.

H. G. Prout, Vice-President and General Manager, Union Switch & Signal Co., Swissvale, Pa.

R. O. Rote, Principal Assistant Engineer, Lake Shore & Michigan Southern Railway, Cleveland, O.

H. J. Simmons, General Manager, El Paso & Southwestern Railway, El Paso, Texas.

XIII. WATER SERVICE.

G. M. Davidson, Chemist and Engineer of Tests, Chicago & Northwestern Railway, Chicago, Ill., *Chairman.*

Anthony McGill, Assistant Analyst, Inland Revenue, Canadian Government, Ottawa, Canada, *Vice-Chairman.*

Geo. Crocker, Chief Engineer, Detroit Southern Railroad, Springfield, O.
C. A. Morse, Acting Chief Engineer, Santa Fe Coast Lines, Los Angeles, Cal.
R. S. Parsons, Engineer Maintenance of Way, Erie Railroad, Cleveland, O.
J. P. Ramsey, General Manager, Chicago, Peoria & St. Louis Railway, St. Louis, Mo.
E. J. Randall, Principal Assistant Engineer, Bessemer & Lake Erie Railroad, Greenville, Pa.
H. S. Waterman, Chief Engineer, Detroit & Mackinac Railway, East Tawas, Mich.
M. H. Wickhorst, Engineer of Tests, Chicago, Burlington & Quincy Railroad, Aurora, Ill.
K. J. C. Zinck, Grand Trunk Railway, Montreal, Canada.

XIV. YARDS AND TERMINALS.

J. A. Atwood, Chief Engineer, Pittsburg & Lake Erie Railroad, Pittsburg, Pa., *Chairman.*
E. E. R. Tratman, Resident Editor, *Engineering News,* Chicago, Ill., *Vice-Chairman.*
A. B. Corthell, Terminal Engineer, New York Central & Hudson River Railroad, New York, N. Y.
E. P. Dawley, Engineer of Construction, New York, New Haven & Hartford Railroad, New Haven, Conn.
W. A. Garrett, General Manager, Cincinnati, New Orleans & Texas Pacific Railway, Cincinnati, O.
B. H. Mann, Signal Engineer, Missouri Pacific Railway, St. Louis, Mo.
J. D. Mason, Engineering Department, Chicago, Burlington & Quincy Railroad, Chicago, Ill.
I. G. Rawn, General Manager, Illinois Central Railroad, Chicago, Ill.
C. S. Sims, Assistant to President, Erie Railroad, New York, N. Y.
F. S. Stevens, Superintendent, Philadelphia & Reading Railway, Reading, Pa.
J. E. Taussig, Terminal Superintendent, Wabash Railroad, St. Louis, Mo.

XV. IRON AND STEEL STRUCTURES.

J. P. Snow, Bridge Engineer, Boston & Maine Railroad, Boston, Mass., *Chairman.*
C. F. Loweth, Engineer and Superintendent Bridges and Buildings, Chicago, Milwaukee & St. Paul Railway, Chicago, Ill., *Vice-Chairman.*
John Brunner, Assistant General Superintendent, North Works, Illinois Steel Company, Chicago, Ill., *Secretary.*
M. F. Brown, Chief Engineer, Boston Bridge Works, Boston, Mass.
C. H. Cartlidge, Bridge Engineer, Chicago, Burlington & Quincy Railroad, Chicago, Ill.

C. L. Crandall, Professor of Railroad Engineering, Cornell University, Ithaca, N. Y.

J. E. Greiner, Assistant Chief Engineer, Baltimore & Ohio Railroad, Baltimore, Md.

Robt. Hawxhurst, Jr., Consulting Engineer, Tacoma, Wash.

Chas. M. Mills, Principal Assistant Engineer, Elevated Railroad and Subway, Philadelphia, Pa.

A. D. Page, Engineer Bridges and Buildings, Chicago, Rock Island & Pacific Railway, Chicago, Ill.

C. D. Purdon, Engineer Maintenance of Way, St. Louis & San Francisco Railway, St. Louis, Mo.

A. F. Robinson, Bridge Engineer, Santa Fe Railway System, Chicago, Ill.

C. C. Schneider, Consulting Engineer, American Bridge Company, Philadelphia, Pa.

J. R. Worcester, Consulting Engineer, Boston, Mass.

XVI. ECONOMICS OF RAILWAY LOCATION.

W. McNab, Assistant Engineer, Grand Trunk Railway System, Montreal, Canada, *Chairman.*

J. B. Berry, Chief Engineer, Chicago, Rock Island & Pacific Railway, Chicago, Ill., *Vice-Chairman.*

C. Frank Allen, Professor of Railroad Engineering, Mass. Inst. of Tech., Boston, Mass.

V. G. Bogue, Civil Engineer, 15 William St., New York.

W. W. Colpitts, Assistant Chief Engineer, Kansas City, Mexico & Orient Railway, Kansas City, Mo.

W. L. Darling, Chief Engineer, Pacific Railway, Seattle, Wash.

A. C. Dennis, Division Engineer, Grand Trunk Pacific Railway, Winnipeg, Man.

Lewis Kingman, Chief Engineer, Mexican Central Railway, City of Mexico, Mex.

O. E. Selby, Assistant Engineer, Cleveland, Cincinnati, Chicago & St. Louis Railway, Cincinnati, O.

W. B. Storey, Jr., Chief Engineer, Atchison, Topeka & Santa Fe Ry., Topeka, Kan.

Francis Lee Stuart, Chief Engineer, Erie Railroad, New York, N. Y.

W. D. Taylor, Professor of Railroad Engineering, University of Wisconsin, Madison, Wis.

W. F. Tye, Chief Engineer, Canadian Pacific Railway, Montreal, Canada.

SPECIAL COMMITTEE ON CLASSIFICATION OF TRACK.

Chas. S. Churchill, Chief Engineer, Norfolk & Western Railway, Roanoke, Va., *Chairman.*

W. M. CAMP, Editor, *Railway and Engineering Review*, Chicago, Ill., *Vice-Chairman.*

C. H. ACKERT, Vice-President, Southern Railway, Washington, D. C.

D. D. CAROTHERS, Chief Engineer, Baltimore & Ohio Railroad, Baltimore, Md.

W. C. CUSHING, Chief Engineer Maintenance of Way, S. W. Sys., Pennsylvania Lines, Pittsburg, Pa.

W. A. GARDNER, General Manager, Chicago & Northwestern Railway, Chicago, Ill.

W. J. HARAHAN, Vice-President, Illinois Central Railroad, Chicago, Ill.

WM. HUNTER, Chief Engineer, Philadelphia & Reading Railway, Philadelphia, Pa.

J. KRUTTSCHNITT, Director Maintenance and Operation, Harriman Lines, Chicago, Ill.

WM. MICHEL, Engineer Maintenance of Way, Hocking Valley Railway, Columbus, O.

C. A. WILSON, Chief Engineer, Cincinnati, Hamilton & Dayton Railway, Cincinnati, O.

H. R. WILLIAMS, President, Pacific Railway, Seattle, Wash.

MEMBERSHIP AND MILEAGE OF RAILWAYS REPRESENTED IN THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION

Name of Road and Membership.	Members.	Mileage.
Alaska Central Railway	1	21
W. B. Poland, Seward, Alaska.		
Ann Arbor Railroad	1	292
O. D. Richards, Toledo, O.		
Antofagasta & Bolivia Railroad	1	586
A. Hohagen, Antofagasta, Chili, S. A.		
Argentine Republic Railways	1	2,000
G. F. T. Dominico, Buenos Ayres, Arg. Rep.		
Atchison, Topeka & Santa Fe Railway System	14	8,296
J. W. Kendrick, Chicago, Ill.		
James Dun, Chicago, Ill.		
W. B. Storey, Jr., Topeka, Kan.		
R. B. Burns, Los Angeles, Cal.		
C. F. W. Felt, Galveston, Texas.		
C. A. Morse, Los Angeles, Cal.		
A. F. Robinson, Chicago, Ill.		
E. O. Faulkner, Topeka, Kan.		
Thomas S. Stevens, Topeka, Kan.		
J. M. Meade, Topeka, Kan.		
F. M. Bisbee, La Junta, Colo.		
L. D. Smith, Galveston, Texas.		
T. S. Cafferty, Topeka, Kan.		
C. S. Corrigan, Galveston, Texas.		
Atlantic & Birmingham Railroad	1	331
Alex. Bonnyman, Oglethorpe, Ga.		
Baltimore & Ohio Railroad	24	4,442
L. G. Haas, Baltimore, Md.		
D. D. Carothers, Baltimore, Md.		
J. B. Dickson, Baltimore, Md.		
J. E. Greiner, Baltimore, Md.		
H. E. Hale Baltimore, Md.		
H. H. Temple, Pittsburg, Pa.		
H. R. Talcott, Baltimore, Md.		
C. E. Bryan, Parkersburg, W. Va.		
Paul Didier, Allegheny, Pa.		
V. K. Hendricks, Baltimore, Md.		
L. G. Curtis, Chicago, Ill.		
J. T. Wilson, Ellicott City, Md.		
W. B. Redgrave, St. George, S. I., N. Y.		
Osmond Rickert, Grafton, W. Va.		
John R. Leighty, Cumberland, Md.		
E. G. Lane, New Castle, Pa.		

Name of Road and Membership.	Members.	Mileage.
Baltimore & Ohio Railroad—Continued.		
John Ware, Connellsville, Pa.		
L. P. Rossiter, Pittsburg, Pa.		
A. S. Woodle, Jr., Wheeling, W. Va.		
S. A. Jordan, Cleveland, O.		
J. B. Jenkins, Pittsburg, Pa.		
L. C. James, Bridgeport, O.		
H. A. Lane, Chillicothe, O.		
F. J. Bachelder, Winchester, Va.		
Baltimore & Ohio Southwestern Railroad	3	918
Earl Stimson, Cincinnati, O.		
L. F. Boeh, Cincinnati, O.		
W. Archer, Cincinnati, O.		
Bessemer & Lake Erie Railroad	2	216
H. T. Porter, Greenville, Pa.		
E. J. Randall, Greenville, Pa.		
Boston & Albany Railroad	1	392
Walter Shepard, Boston, Mass.		
Boston & Maine Railroad	1	2,287
J. P. Snow, Boston, Mass.		
*British Columbia Railway	1	
H. W. Warrington, Grand Forks, B. C.		
Buffalo & Susquehanna Railroad	2	172
H. Herden, Galeton, Pa.		
H. C. Landon, Galeton, Pa.		
Buffalo, Rochester & Pittsburg Railway	1	475
J. M. Floesch, Rochester, N. Y.		
Burlington Route	12	8,511
Chicago, Burlington & Quincy:		
D. Willard, Chicago, Ill.		
T. E. Calvert, Chicago, Ill.		
W. L. Breckinridge, Chicago, Ill.		
L. F. Goodale, St. Louis, Mo.		
G. H. Bremner, Chicago, Ill.		
C. H. Cartlidge, Chicago, Ill.		
M. H. Wickhorst, Aurora, Ill.		
J. D. Mason, Chicago, Ill.		
John C. Sesser, Centralia, Ill.		
F. M. Patterson, Chicago, Ill.		
E. P. Weatherly, St. Joseph, Mo.		
E. C. Forbush, Herrin, Ill.		
Cammal & Black Forest Railroad	1	31
C. B. McCullough, Jersey Shore, Pa.		
Canadian Northern Railway	3	2,170
H. F. Forrest, Winnipeg, Man.		
R. B. Pratt, Winnipeg, Man.		
D. A. Ross, Winnipeg, Man.		

* Under construction.

Name of Road and Membership.	Members.	Mileage.
Canadian Pacific Railway	7	8,986
J. W. Leonard, Winnipeg, Man.		
W. F. Tye, Montreal, Can.		
F. P. Gutelius, Montreal, Can.		
W. A. James, Winnipeg, Man.		
A. L. Buck, Montreal, Can.		
M. P. Cotton, Winnipeg, Man.		
H. L. Jordan, Montreal, Can.		
Central of Georgia Railway	2	1,867
Henry M. Steele, Savannah, Ga.		
J. C. Gray, Chipley, Ga.		
Central Railroad of New Jersey	3	641
W. G. Besler, New York, N. Y.		
Jos. O. Osgood, Jersey City, N. J.		
A. L. Bowman, New York, N. Y.		
Central Railway of Guatemala	1	141
D. B. Hodgsdon, Guatemala City, Guat., C. A.		
Central Vermont Railway	1	531
J. M. Morrison, St. Albans, Vt.		
Chesapeake & Ohio Railway	1	1,670
H. Pierce, Richmond, Va.		
Chicago & Alton Railway	3	915
S. M. Felton, Chicago, Ill.		
W. B. Causey, Bloomington, Ill.		
C. S. Ells, Roodhouse, Ill.		
Chicago & Eastern Illinois Railroad	4	921
W. S. Dawley, Chicago, Ill.		
R. H. Howard, Chicago, Ill.		
A. S. Markley, Danville, Ill.		
Ralph McCalman, Villa Grove, Ill.		
Chicago & Northwestern Railway	6	7,411
W. A. Gardner, Chicago, Ill.		
R. H. Aishton, Chicago, Ill.		
F. H. Bainbridge, Chicago, Ill.		
G. M. Davidson, Chicago, Ill.		
J. A. Peabody, Chicago, Ill.		
L. J. McIntyre, Chicago, Ill.		
Chicago & Western Indiana Railway	3	49
E. H. Lee, Chicago, Ill.		
A. S. Zinn, Chicago, Ill.		
S. D. Pugh, Chicago, Ill.		
Chicago Great Western Railway	2	1,321
Ole Davidson, Clarion, Iowa.		
Chicago, Indianapolis & Louisville Railway	2	536
A. S. Kent, Chicago, Ill.		
W. A. Wallace, Chicago, Ill.		
Chicago Junction Railway	1	243
J. B. Cox, Chicago, Ill.		

Name of Road and Membership.	Members.	Mileage.
Chicago, Milwaukee & St. Paul Railway	4	7,185
D. J. Whittemore, Chicago, Ill.		
J. B. Moll, Chicago, Ill.		
C. F. Loweth, Chicago, Ill.		
G. B. Woodworth, Chicago, Ill.		
Chicago, Peoria & St. Louis Railway	2	245
J. P. Ramsey, St. Louis, Mo.		
J. K. Howard, Springfield, Ill.		
Chicago, Rock Island & Pacific Railway	7	6,836
J. B. Berry, Chicago, Ill.		
H. F. White, Chicago, Ill.		
A. D. Page, Chicago, Ill.		
J. G. Bloom, Topeka, Kan.		
Garrett Davis, Cedar Rapids, Ia.		
W. H. Davisson, Topeka, Kan.		
G. E. Ellis, Chicago, Ill.		
*Chicago Southern Railway	2	
E. H. Pfafflin, Chicago, Ill.		
F. R. Puder, Chicago, Ill.		
Chicago Terminal Transfer Railroad	1	259
J. N. Faithorn, Chicago, Ill.		
Chicago Union Transfer Company	1	100
M. E. Shire, Chicago, Ill.		
Cincinnati & Muskingum Valley Railroad	1	149
Paul Jones, Zanesville, O.		
Cincinnati, Hamilton & Dayton Railway	2	1,015
C. A. Wilson, Cincinnati, O.		
I. F. White, Dayton, O.		
Cincinnati Northern Railroad	1	236
W. D. Williams, Van Wert, O.		
Cleveland, Akron & Columbus Railway	1	214
R. C. Barnard, Akron, O.		
Cleveland, Cincinnati, Chicago & St. Louis Ry. System	11	2,276
Geo. W. Kittredge, Cincinnati, O.		
O. E. Selby, Cincinnati, O.		
Hadley Baldwin, Mattoon, Ill.		
C. A. Paquette, Indianapolis, Ind.		
M. A. Neville, Indianapolis, Ind.		
Charles S. Millard, Indianapolis, Ind.		
H. H. Knowlton, Cincinnati, O.		
L. S. Rose, Mattoon, Ill.		
Robt. H. Moore, Mt. Carmel, Ill.		
Paul Hamilton, Springfield, O.		
F. W. Hawks, Chicago, Ill.		
Colorado & Southern Railroad	1	1,121
H. W. Cowan, Denver, Colo.		

*Under construction.

Name of Road and Membership.	Members.	Mileage.
Davenport, Rock Island & Northwestern Railroad.....	1	53
Chas. E. Sheriff, Davenport, Ia.		
Delaware, Lackawanna & Western.....	1	952
Lincoln Bush, Hoboken, N. J.		
Delaware, Susquehanna & Schuylkill Railroad	1	76
Edgar Kudlich, Drifton, Pa.		
Denver, Enid & Gulf Railway.....	1	70
Ed. L. Peckham, Enid, Okla.		
Detroit & Mackinac Railroad	1	334
H. S. Waterman, East Tawas, Mich.		
Detroit Southern Railroad	1	473
Geo. Crocker, Springfield, O.		
Detroit United Street Railways.....	1	533
J. C. Hutchins, Detroit, Mich.		
Duluth, Missabe & Northern Railroad.....	1	163
W. A. McGonagle, Duluth, Minn.		
Duluth, South Shore & Atlantic	1	575
V. D. Simar, Marquette, Mich.		
Elgin, Joliet & Eastern and Chicago, Lake Shore & Eastern Railways	1	386
Arthur Montzheimer, Joliet, Ill.		
El Paso & Southwestern Railroad.....	2	340
H. J. Simmons, El Paso, Tex.		
J. L. Campbell, El Paso, Texas.		
Erie Railroad	10	2,553
F. D. Underwood, New York, N. Y.		
J. C. Stuart, New York, N. Y.		
Francis Lee Stuart, New York, N. Y.		
C. S. Sims, Mount Holly, N. J.		
R. S. Parsons, Cleveland, O.		
W. H. Peddle, Jersey City, N. J.		
C. H. Moore, New York, N. Y.		
R. A. Van Houten, Susquehanna, Pa.		
W. B. Taylor, Buffalo, N. Y.		
A. G. Norton, Otisville, N. Y.		
Esquimalt & Nanaimo Railway.....	1	80
Jos. Hunter, Victoria, B. C.		
*Ferro-Carril Occidental de Guatemala.....	1	
J. B. Hatch, San Felipe, Guat., C. A.		
Fonda, Johnstown & Gloversville Railroad.....	1	77
F. A. Bagg, Gloversville, N. Y.		
*Goderich & Guelph Railway.....	2	
P. Alex. Peterson, Goderich, Ont.		
F. D. Anthony, Goderich, Ont.		

*Under construction.

Name of Road and Membership.	Members.	Mileage.
Government Railways of Japan..... Daiske Nishi, Tokio, Japan.	1	1,344
Grand Rapids & Indiana Railway ..... F. J. Stimson, Grand Rapids, Mich.	1	620
Grand Trunk Railway System..... E. H. Fitzhugh, Montreal, Can. F. H. McGuigan, Montreal, Can. H. A. Woods, Montreal, Can. W. McNab, Montreal, Can. A. C. Dennis, Winnipeg, Man. T. L. Hanley, Grand Rapids, Mich. M. S. Blaiklock, Montreal, Can. K. J. C. Zinck, Montreal, Can.	8	4,177
Great Northern Railway ..... J. R. W. Davis, St. Paul, Minn. Chas. A. Dunham, St. Paul, Minn. J. M. Dixon, Fremont, Neb. R. C. St. John, Grand Forks, N. D.	4	5,984
*Guatemala Railway ..... J. T. Norton, Puerto Barrios, Guat., C. A.	1	
Halifax & Southwestern Railway..... L. H. Wheaton, Shelburne, N. S.	1	374
Hankaku Railways ..... Kyoichi Murakami, Kitahama, Osaka, Japan.	1	69
Hocking Valley Railroad ..... Wm. Michel, Columbus, O.	1	346
Hokkaido Tanko Railway of Japan ..... T. Ohmra, Iwanizawa, Japan.	1	207
Illinois Central Railroad..... W. J. Harahan, Chicago, Ill. I. G. Rawn, Chicago, Ill. L. C. Fritch, Chicago, Ill. A. S. Baldwin, Chicago, Ill. H. R. Safford, Chicago, Ill. C. Dougherty, Clinton, Ill. O. M. Dunn, New Orleans, La. R. B. Starbuck, Mattoon, Ill. J. C. Dailey, Chicago, Ill. H. W. Parkhurst, Chicago, Ill. W. A. D. Short, Chicago, Ill. A. E. Harvey, Indianapolis, Ind. E. I. Rogers, Covington, Tenn. H. R. Dill, Evansville, Ind. C. W. Pifer, Chicago, Ill. R. S. Blinn, Bloomington, Ind.	16	4,343
Indiana Harbor Railroad..... C. W. Hotchkiss, Chicago, Ill.	1	70

*Under construction.

Name of Road and Membership.	Members.	Mileage.
International Railway of Buffalo T. W. Wilson, Buffalo, N. Y.	1	355
Jacksonville & St. Louis Railway B. F. Bond, Jacksonville, Ill.	1	121
Jacksonville & Southwestern Railway Roland Woodward, Jacksonville, Fla.	1	90
Kansas City Belt Railway G. M. Walker, Jr., Kansas City, Mo.	1	52
Kansas City, Mexico & Orient Railway E. Dickinson, Kansas City, Mo. M. P. Paret, Kansas City, Mo. W. W. Colpitts, Kansas City, Mo.	3	500
Kansas City Southern Railway A. F. Rust, Kansas City, Mo.	1	762
Lake Erie & Western Railway G. C. Cleveland, Indianapolis, Ind.	1	719
Lake Shore & Michigan Southern Railway E. A. Handy, Cleveland, O. Samuel Rockwell, Cleveland, O. F. E. Bissell, Cleveland, O. R. O. Rote, Cleveland, O. Frank Beckwith, Cleveland, O.	5	1,520
Lake Superior & Ishpeming Railroad, Munising Railway, and Marquette & Southeastern Railway R. C. Young, Marquette, Mich.	1	119
Lehigh Valley Railroad Walter G. Berg, New York, N. Y. E. B. Ashby, South Bethlehem, Pa. F. E. Schall, South Bethlehem, Pa.	3	1,393
Long Island Railroad C. L. Addison, Long Island City, N. Y. J. B. Austin, Jr., Jamaica, N. Y.	2	392
Louisville & Nashville Railroad R. Montfort, Louisville, Ky. W. H. Courtenay, Louisville, Ky. J. E. Willoughby, Knoxville, Tenn. J. F. Burns, Elizabethtown, Ky.	4	4,020
Macon, Dublin & Savannah Railroad J. T. Wright, Macon, Ga.	1	92
Madras Railway E. W. Stoney, Madras, India.	1	84.1
Maine Central Railroad B. W. Guppy, Portland, Me.	1	821

Name of Road and Membership.	Members.	Mileage.
Marinette, Tomahawk & Western Railroad..... R. B. Tweedy, Milwaukee, Wis.	1	50
Mexican Central Railway ..... A. A. Robinson, New York, N. Y. E. E. Styner, City of Mexico, Mexico. Lewis Kingman, City of Mexico, Mexico. Hans Bentele, City of Mexico, Mexico. W. C. Bradley, Tampico, Mexico. E. S. Banks, Guadalajara, Mexico.	6	3,155
Mexican International Railway ..... C. T. Norton, Porfirio Diaz, Mexico. Rankin Johnson, Durango, Mexico. F. W. Andros, Durango, Mexico. C. J. Carroll, Durango, Mexico.	4	1,564
Mexican National Construction Company ..... A. P. Herbert, Colima, Mexico.	1	89
Mexican Southern Railway..... W. L. Morkill, Puebla, Mexico.	1	263
Michigan Central Railroad ..... W. S. Kinnear, Detroit, Mich. G. H. Webb, Detroit, Mich. B. Douglas, Detroit, Mich. J. C. Mock, Detroit, Mich. D. L. Parker, Jackson, Mich. T. H. Hickey, St. Thomas, Ont.	6	1,662
Midland Valley Railroad ..... F. A. Molitor, St. Louis, Mo.	1	198
*Midway & Vernon Railway..... W. I. Bassett, Midway, B. C.	1	
*Military Railway of Japan..... T. Endo, Chemulpo, Corea.	1	
Minneapolis & Rainy River Railroad..... A. L. Davis, Deer River, Minn.	1	40
Minneapolis & St. Louis Railway..... Iowa Central Railway. H. G. Kelley, Minneapolis, Minn.	1	1,245
Minneapolis, St. Paul & Sault Ste. Marie Railway..... E. Pennington, Minneapolis, Minn.	1	1,829
Mississippi Central Railroad ..... M. J. Epley, Hattiesburg, Miss.	1	55
Missouri, Kansas & Texas Railway..... S. B. Fisher, St. Louis, Mo.	1	3,043

*Under construction.

Name of Road and Membership.	Members.	Mileage.
Missouri Pacific Railway	7	6,237
St. Louis, Iron Mountain & Southern.		
C. S. Clarke, St. Louis, Mo.		
A. W. Sullivan, St. Louis, Mo.		
J. W. Higgins, St. Louis, Mo.		
H. Rohwer, St. Louis, Mo.		
M. L. Byers, St. Louis, Mo.		
B. H. Mann, St. Louis, Mo.		
H. Devereux, Batesville, Ark.		
Mobile & Ohio Railroad	3	955
T. L. Condron, Chicago, Ill.		
C. F. Blue, Cairo, Ill.		
B. A. Wood, Meridian, Miss.		
Mobile, Jackson & Kansas City Railroad	1	258
T. F. Whittelsey, Mobile, Ala.		
Monongahela Railroad	1	58
D. K. Orr, Brownsville, Pa.		
Moscow-Kursk Railway	1	692
Theo. Schidlovsky, Moscow, Russia.		
*Muskogee Southern Railroad	1	
H. S. Moore, Muskogee, I. T.		
Nashville, Chattanooga & St. Louis Railway	4	1,200
J. W. Thomas, Jr., Nashville, Tenn.		
Hunter McDonald, Nashville, Tenn.		
G. D. Hicks, Tullahoma, Tenn.		
I. O. Walker, Paducah, Ky.		
National Railway of Tehuantepec	1	210
John B. Body, City of Mexico, Mexico.		
*National Transcontinental Railway	2	
Duncan MacPherson, Ottawa, Ont.		
A. N. Molesworth, Ottawa, Ont.		
New Orleans Terminal Railway	2	23
F. G. Jonah, New Orleans, La.		
A. L. Phillips, New Orleans, La.		
New York Central & Hudson River Railroad	5	2,881
W. J. Wilgus, New York, N. Y.		
G. W. Vaughan, New York, N. Y.		
A. B. Corthell, New York, N. Y.		
H. S. Balliet, New York, N. Y.		
G. F. Morse, New York, N. Y.		
New York, Chicago & St. Louis Railway	4	523
A. W. Johnston, Cleveland, O.		
E. E. Hart, Cleveland, O.		
A. J. Himes, Cleveland, O.		
C. B. Hoyt, Bellevue, O.		

*Under construction.

Name of Road and Membership.	Members.	Mileage.
New York, New Haven & Hartford Railroad..... E. H. McHenry, New Haven, Conn. E. P. Dawley, New Haven, Conn. W. H. Moore, New Haven, Conn. W. L. Derr, Hartford, Conn.	4	2,037
New York, Ontario & Western Railway ..... C. E. Knickerbocker, Middletown, N. Y.	1	494
New York, Philadelphia & Norfolk Railroad..... J. G. Rodgers, Cape Charles, Va.	1	112
Nippon Railway of Japan..... S. Sugiura, Tokio, Japan.	1	860
Norfolk & Southern Railway..... F. L. Nicholson, Norfolk, Va.	1	192
Norfolk & Western Railway..... C. S. Churchill, Roanoke, Va.	1	1,745
Northern Pacific Railway..... Howard Elliott, St. Paul, Minn. E. J. Pearson, St. Paul, Minn.	2	5,305
North Shore Railroad ..... James L. Frazier, San Francisco, Cal.	1	31
Ohio River & Columbus Railway..... G. C. Millett, Ripley, O.	1	24
Oregon Short Line..... Wm. Ashton, Salt Lake City, Utah. L. L. Dagron, Salt Lake City, Utah. H. B. Merriam, Salt Lake City, Utah.	2	1,266
Pacific Electric Railway ..... Los Angeles Interurban Railway. A. D. Schindler, Los Angeles, Cal.	1	345
*Pacific Railway ..... H. R. Williams, Seattle, Wash. W. L. Darling, Seattle, Wash. C. H. Byers, Seattle, Wash.	3	
Pennsylvania Lines West of Pittsburg..... Thos. Rodd, Pittsburg, Pa. W. C. Cushing, Pittsburg, Pa. R. Trimble, Pittsburg, Pa. E. G. Ericson, Pittsburg, Pa. A. A. Wirth, Pittsburg, Pa.	5	2,712
Pennsylvania Railroad ..... Jos. T. Richards, Philadelphia, Pa. Robt. Bell, Buffalo, N. Y. E. F. Kenney, Philadelphia, Pa. W. S. Thompson, Oil City, Pa. A. H. Rudd, Philadelphia, Pa.	5	5,190
Peoria & Pekin Union Railroad..... Curtiss Millard, Peoria, Ill.	1	20

*Under construction.

Name of Road and Membership.	Members.	Mileage.
Pere Marquette Railroad	3	2,108
Job Tuthill, Detroit, Mich.		
G. H. Bristol, Detroit, Mich.		
J. F. Deimling, Grand Rapids, Mich.		
Philadelphia & Reading Railway	4	1,469
Wm. Hunter, Philadelphia, Pa.		
F. S. Stevens, Reading, Pa.		
J. E. Turk, Tamaqua, Pa.		
C. H. Ewing, Reading, Pa.		
Philadelphia Elevated Railroad & Subway	1	
Chas. M. Mills, Philadelphia, Pa.		
Pittsburg & Lake Erie Railroad	4	191
J. A. Atwood, Pittsburg, Pa.		
A. R. Raymer, Pittsburg, Pa.		
Edwin F. Wendt, Pittsburg, Pa.		
E. W. Boots, McKeesport, Pa.		
Queen & Crescent Route	6	1,158
W. A. Garrett, Cincinnati, Ohio.		
C. C. Harvey, New Orleans, La.		
E. Ford, Vicksburg, Miss.		
H. M. Waite, Somerset, Ky.		
J. C. Nelson, Birmingham, Ala.		
J. C. Haugh, New Orleans, La.		
St. Louis & North Arkansas Railroad	1	130
G. L. Sands, Eureka Springs, Ark.		
St. Louis & San Francisco Railway	4	4,738
A. J. Davidson, St. Louis, Mo.		
J. F. Hinckley, St. Louis, Mo.		
C. D. Purdon, St. Louis, Mo.		
J. V. Hanna, St. Louis, Mo.		
San Francisco & Northwestern Railway	1	52
H. C. Phillips, San Francisco, Cal.		
San Pedro, Los Angeles & Salt Lake City Railroad	1	633
E. M. Jessup, Los Angeles, Cal.		
Santa Fe, Prescott & Phœnix Railway	1	350
W. A. Drake, Prescott, Ark.		
Sanyo Railroad	1	370
Junnosuke Yamaguchi, Kobe, Japan.		
Seaboard Air Line	1	2,611
D. B. Dunn, Portsmouth, Va.		
South & Western Railway	1	64
W. I. Lee, Spruce Pine, N. C.		
South Side Elevated Railroad	1	18
C. V. Weston, Chicago, Ill.		
Southern Indiana Railway	2	148
E. H. Pfafflin, Chicago, Ill.		
J. F. Cassell, Terre Haute, Ind.		

Name of Road and Membership.	Members.	Mileage.
Southern Pacific Company	12	7,964
J. Kruttschnitt, Chicago, Ill.		
W. G. Van Vleck, Houston, Texas.		
R. Koehler, Portland, Ore.		
Wm. Hood, San Francisco, Cal.		
J. H. Wallace, San Francisco, Cal.		
E. B. Cushing, New Orleans, La.		
J. A. Naugle, Guaymas, Mexico.		
T. Fitzgerald, Ogden, Utah.		
E. L. Swaine, Los Angeles, Cal.		
C. C. Mallard, Houston, Texas.		
F. C. Miller, Sacramento, Cal.		
A. F. Moursund, Lafayette, La.		
Southern Railway	4	7,201
C. H. Ackert, Washington, D. C.		
D. W. Lum, Washington, D. C.		
H. Baker, Greensboro, N. C.		
B. C. Milner, Louisville, Ky.		
Spokane International Railway	2	140
E. G. Taber, Spokane, Wash.		
J. H. Abbott, Spokane, Wash.		
Susquehanna & New York Railroad	1	60
C. A. Derr, Williamsport, N. Y.		
Temiskaming & Northern Ontario Railway	1	113
G. A. McCarthy, North Bay, Ont.		
Texas Midland Railway	1	125
L. W. Wells, Terrell, Texas.		
*Tidewater Railway	2	
H. Fernstrom, Norfolk, Va.		
B. T. Elmore, Norfolk, Va.		
Union Belt Railway	1	22
H. G. Fleming, Memphis, Tenn.		
Union Pacific Railroad	7	2,956
R. L. Huntley, Omaha, Neb.		
H. C. Ferris, Denver, Colo.		
James Keys, Omaha, Neb.		
A. D. Schermerhorn, Omaha, Neb.		
A. K. Shurtleff, Omaha, Neb.		
C. C. Post, Jr., Omaha, Neb.		
John C. Beye, Kansas City, Mo.		
Union Railroad	1	57
E. C. Brown, Port Perry, Pa.		
Union Stock Yards & Railroad Company	2	50
Wm. J. C. Kenyon, South Omaha, Neb.		
W. S. King, South Omaha, Neb.		
Union Terminal Railway (of Sioux City)	1	16
B. S. Josselyn, Philadelphia, Pa.		

*Under construction.

Name of Road and Membership.	Members.	Mileage.
Vandalia Line	2	804
F. T. Hatch, St. Louis, Mo.		
Maurice Coburn, Terre Haute, Ind.		
Vera Cruz & Pacific Railway	1	426
W. A. Hill, Vera Cruz, Mexico.		
Victorian State Railways	1	3,113
Thos. Tait, Melbourne, Australia.		
Wabash Railroad	9	2,516
F. A. Delano, Chicago, Ill.		
A. O. Cunningham, St. Louis, Mo.		
H. M. Cryder, St. Louis, Mo.		
J. E. Taussig, St. Louis, Mo.		
E. K. Woodward, Peru, Ind.		
A. G. Trippeer, Detroit, Mich.		
Edward Shelah, Decatur, Ill.		
A. C. Butterworth, Chicago, Ill.		
W. W. Greenland, Moberly, Mo.		
Waterloo & Cedar Falls Rapid Transit Co	1	40
M. L. Newton, Waterloo, Iowa.		
Wellington & Manawatu Railway	1	84
James Marchbanks, Wellington, New Zealand.		
Western Maryland Railroad	2	260
Virgil G. Bogue, New York, N. Y.		
A. W. Buel, New York, N. Y.		
Western Railways of Australia	1	1,355
Thos. Watson, Coolgardie, W. Australia.		
Wisconsin & Michigan Railroad	1	72
B. C. Gowen, Peshtigo, Wis.		
Wisconsin Central Lines	2	881
C. N. Kalk, Milwaukee, Wis.		
A. H. Langdon, Milwaukee, Wis.		
Consulting Engineer, etc	88	
Totals	495	200,765

*GENERAL RULES FOR PUBLICATION OF "MANUAL OF RECOMMENDED PRACTICE."

(1) The title of the volume will be *"Manual of Recommended Practice for Railway Engineering and Maintenance of Way,* containing the Definitions, Specifications and Principles of Practice adopted and recommended by the American Railway Engineering and Maintenance of Way Association," edited under the direction of the Committee on Publications and publication approved by the Board of Direction.

(2) The adoption by the Association and subsequent publication of any matter in the Manual shall be considered in the nature of *recommended practice* and shall not be binding on the members.

(3) The Manual shall include only resolutions, conclusions, recommendations, plans, etc., relating to definitions, specifications or principles of practice of such questions connected with railway engineering and maintenance of way work which have been made the subject of a special study by a standing or special committee and embodied in a committee report, published not less than thirty days prior to the annual convention, and submitted by the committee at the annual convention, and which, after due consideration and discussion, shall have been voted on and formally adopted by the Association.

(4) Any matter published in the Manual may be amended, revised, extended or withdrawn by vote at any subsequent annual convention, provided such changes are proposed in time for publication not less than thirty days prior to the annual convention, and in the following manner: (a) Upon recommendation of the committee in charge of the subject; (b) upon recommendation of the Board of Direction; (c) upon request of five members, subject to the action of the Board of Direction under Rule (6).

(5) All resolutions, conclusions, recommendations, specifications, standards, etc., in order to be included in the Manual, must be in concise and proper final shape for publication, as the Manual will consist only of a summary record of the definitions, principles of practice, specifications and standards recommended by the Association, with a brief reference to the published Proceedings of the Association for the context of the committee report and subsequent discussions and the final action by the Association.

(6) The Board of Direction shall have authority to exclude from the Manual any matter which, in its judgment, it shall consider as not desirable to publish, or as not being in proper shape, or as not having received proper study and consideration.

(7) The Manual will be revised annually and kept up-to-date by publishing a new edition or a supplemental pamphlet as promptly as possible after each annual convention.

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* Adopted, March, 1905.

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